National Aeronautics and
Space Administration

Office of Human Resources and Education

Graduate Student Researchers Program (GSRP)

"We involve the educational community in our endeavors to inspire America's students, create learning opportunities, and enlighten inquisitive minds."

--NASA Implementation Plan for Education, 1999-2003

FY 2002 NASA
PROGRAM ANNOUNCEMENT

Release Date:	November 1, 2001
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TABLE OF CONTENTS

GSRP PROGRAM MANAGERS

Questions concerning policy matters should be directed to the Graduate Student Researchers Program (GSRP) National Program Manager.

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GSRP National Program Manager
Office of Human Resources and Education
Code FE
NASA Headquarters
Washington, DC 20546.
(202) 358-0402

Questions concerning the preparation and submission of proposals and the administration of this program are to be directed to the appropriate Program Administrator. The NASA Headquarters Enterprise Offices, Centers, and the Jet Propulsion Laboratory manage their own GSRP proposals under the direction of the following officials. Please direct inquiries to these individuals:

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NASA STRATEGIC ENTERPRISES, CENTERS AND FACILITIES

NASA operates nine Centers nationwide, the contractor-operated Jet Propulsion Laboratory, and the Wallops Flight Facility. NASA's overall program, as outlined in the Agency's Strategic Plan, consists of five Strategic Enterprises. Each Enterprise covers a major area of the agency's research and development efforts. The five NASA Enterprises are described on this page. Code S, Office of Space Science; Code U, Office of Biological and Physical Research; and Code Y, Office of Earth Sciences offer opportunities for the GSRP.

Aerospace Technology —
The mission of this Enterprise is to pioneer the identification, development, verification, transfer, application, and commercialization of high-payoff aeronautics and space transportation technologies. The Enterprise is managed by the Office of Aerospace Technology.

Biological and Physical Research —
The mission of this Enterprise, formerly the Office of Life and Microgravity Sciences and Applications, is to conduct basic and applied research (including clinical research) to support human exploration of space and to take advantage of the space environment as a laboratory for scientific, technological, and commercial research. The Office oversees the effective use of the International Space Station facilities for scientific, commercial and technology research. The Enterprise is managed by the Office of Biological and Physical Research.

Earth Science —
The mission of this Enterprise is to use the unique vantage point of space to provide information about Earth's environment that is obtainable in no other way. In concert with research and industry partners, the Enterprise is developing the understanding needed to support the complex environmental policy and economic investment decisions that lie ahead. The Office of Earth Science manages this Enterprise.

Human Exploration and Development of Space (HEDS) —
The mission of the HEDS Enterprise is to expand the frontiers of space and knowledge by exploring, using, and enabling the development of space for human enterprise. The HEDS Enterprise is managed by the Office of Space Flight.

Space Science —
The mission of the Space Science Enterprise is to solve mysteries of the universe; explore the solar system; discover planets around other stars; search for life beyond Earth from origins to destiny; chart the evolution of the universe and understand its galaxies, stars, planets, and life. The Space Science Enterprise is managed by the Office of Space Science.

More information is available from NASA's Web site, www.nasa.gov. This site also includes specific information about the NASA Centers. Details regarding research opportunities at each NASA Center and the five Strategic Enterprises can be found in this solicitation.

I. INTRODUCTION

Since 1980, the National Aeronautics and Space Administration (NASA) has sponsored the NASA Graduate Student Researchers Program (GSRP) to help meet the continuing needs of the nation's aeronautics and space effort by increasing the number of highly trained scientists and engineers in aerospace; space; Earth; physical and biological sciences; space applications; and space technology.

The NASA Graduate Student Researchers Program (GSRP) awards fellowships for graduate study leading to research-based masters or doctoral degrees in the fields of science, mathematics, and engineering.

This solicitation and the Web site provide information about eligibility, submission of proposals, and the application process. Please spend a few minutes exploring the opportunity to both continue your graduate education and participate in the exciting world of NASA.

II. PROGRAM DESCRIPTION

GRADUATE STUDENT RESEARCH PROGRAM (GSRP)

Initiated in 1980, the goal of GSRP is to cultivate additional research ties to the academic community and broaden the base of students pursuing advanced degrees in science, mathematics, and engineering.

Fellowships are awarded for graduate study leading to research-based masters or doctoral degrees in the fields of science, mathematics, and engineering. This program supports approximately 300 graduate students each year. Students may apply prior to receiving their baccalaureate degree or at any time during their graduate career. A faculty advisor or graduate department chair must sponsor an applicant. Awardees may not simultaneously accept any other Federal fellowships or traineeships. However, under Section 178(a) of Title 38, U.S. Code, educational benefits from the Department of Veterans Affairs may be received at the same time. Upon completion of the research required by the fellowship program, there is no formal obligation for service to the Federal government.

Each year, approximately 90 new awardees are selected based on competitive evaluation of their proposal and academic qualifications. Usually, NASA Headquarters (HQ) sponsors 40 of the new awards through the Office of Space Science (OSS), the Office of Biological and Physical Research (OBPR), and the Office of Earth Science (OES). NASA's discipline scientists competitively evaluate students and their proposals based upon the student's academic qualifications, proposed research, and plan of study. Fellows selected by NASA Headquarters conduct research at their respective universities.

The remaining awards are distributed through the nine NASA Field Centers and the Jet Propulsion Laboratory, each of which has specific research programs and facilities. Fellows selected by Centers must spend some period of time in residence at the Center, taking advantage of the unique research facilities of the installation and working with Center personnel. The projected use of Center expertise and facilities is an important factor in the selection of Center fellows.

Award Size and Duration

Fellowships are awarded for one year as training grants not to exceed $24,000 and are renewable for a total of three years based on satisfactory academic advancement, research progress, and available funding. Fellowship renewal is based on satisfactory progress as evaluated in renewal proposals. The Program Administrator and the Technical Advisor at the appropriate NASA Center or Headquarters Office must approve renewals.

A student receiving support under GSRP does not incur any formal obligation to the Government of the United States. The objectives of this program will be served best if the student actively pursues research, teaching, or employment in NASA-related fields after completion of graduate studies.

The award includes a student stipend, an allowance for student expenses, and an allowance for university expenses. The allowance for student expenses may be used to help defray tuition costs, purchase books and software, or to provide per diem and travel for the student. It may also be used to help defray living expenses during periods of Center residency, if applicable. The allowance for university expenses may be used for tuition or to support research-related travel for the faculty advisor or the student. Alternative uses for this allowance may be requested but must be consistent with the intent of the program.

- **Computer Equipment.** GSRP grant funds cannot be used for the purchase of any equipment, including computers.

All foreign travel charged to the grant must have prior approval of the appropriate GSRP Administrator and NASA Grants Officer and must clearly be relevant to the research effort. For each foreign trip, the student or advisor must submit a written request on university letterhead stating the purpose, estimated cost, travel dates, and GSRP grant number. Requests should be made two months prior to the proposed travel. Requests that are submitted after the travel has been completed will be denied.

- **Unused Funds**. If a student withdraws **within the first half of the award year**, the award will be prorated and the remaining funds returned to NASA. Continuing GSRP fellows who have funds remaining from their previous year's budget may carry the remaining funds over into the following program year.

All questions concerning taxes should be directed to the Internal Revenue Service. Refer to IRS Publication 520, "Scholarships and Fellowships," and Publication 508, "Tax Benefits for Work-Related

Education," for further information. Both publications can be accessed at the following web site address http://www.irs.gov/prod/forms_pubs/pubs/.

General Eligibility Requirements

All applicants must be either currently enrolled as full-time graduate students in an accredited U.S. college or university or making plans to enroll as a full-time student. Applicants must be citizens of the U.S. and may apply to the program prior to receiving their baccalaureate degrees or any time during their graduate work. Students who apply prior to acceptance in graduate school must submit a list of prospective schools, and if selected, must provide proof of acceptance prior to an award. All applicants must have a faculty advisor or graduate department chair sponsor. An individual accepting this award may not concurrently receive other Federal fellowships or traineeships. African Americans, Native Americans, Mexican Americans, Puerto Ricans, Alaskan Natives, Native Pacific Islanders, women, and persons with disabilities are strongly urged to apply. No applicant shall be denied consideration or appointment as a NASA GSRP fellow on the grounds of race, creed, color, national origin, age, sex, or disability.

Award Transfer

If a student discontinues participation in the program after the first six months of the award period, the university may nominate another student with similar achievement and research objectives to complete the remaining months of the current award year.

Documentation required for nomination of replacement students must include: a) a written statement by the original student giving the date and reason for withdrawal from the program; b) a proposal cover sheet signed by the replacement student and faculty advisor; c) a transcript; and d) a brief description of the student's research and educational background, on university letterhead. If the nominated replacement student is approved, an amendment to the grant will be issued. The GSRP Administrator and NASA Grants Officer must approve replacement students.

Replacement students electing to apply to the GSRP for the following program year are subject to the evaluation and selection procedures administered to new applicants. Replacement students selected as new applicants will be eligible for up to three full years of support, depending upon satisfactory progress and available funding.

Reporting Requirements

It is the responsibility of the institution receiving a NASA GSRP award to ensure submission of a final report on the fellow's research and academic progress. This report is due no later than 90 days after the termination date of the award. The report must include the degree granted, important student achievements (e.g., thesis title, other published papers, presentations, awards, honors), and employment or other future plans. This report should be submitted to the appropriate NASA Center or Headquarters GSRP Administrator and the relevant Grants Office.

Awarded students must complete an evaluation of the GRSP award and their related experiences by accessing the online evaluation form at https://ehb2.gsfc.nasa.gov/edcats/stud_eval.html.

III. PROPOSAL EVALUATION AND SUBMISSION GUIDELINES

Proposal Submission

All new and renewal applicants must submit an original and five (5) copies of all application materials **by February 1, 2002,** to the appropriate NASA Headquarters or Center Program Administrator listed in this handbook. For detailed guidelines on proposal preparation, see the section entitled Proposal Preparation.

Applications will be reviewed and selections made in early May 2002. New awards are scheduled to begin the first of July, August, or September 2002. GSRP renewals are not automatic. Incomplete or late proposals will not be renewed. The starting date for renewals will be one year from the start of the original fellowship.

The student must write the GSRP proposal. To ensure the preparation of a competitive proposal, students are strongly encouraged to collaborate with a faculty member and with a potential NASA Technical Advisor to identify a project. Students are advised to solicit guidance, review, and commentary on the proposal from their faculty advisor prior to submission. It is important that new and renewal student applicants submit the appropriate proposal materials. See the sections for new applicants and renewals under the section entitled Proposal Preparation.

To facilitate the recycling of proposals after review, proposals should be submitted on plain, white paper only. Do not use cardboard stock, plastic covers, spiral binders, colored paper, etc. Refer to the appendices for the cover sheet and certifications of compliance required for this application.

Evaluation Criteria

NASA Headquarters, Centers, or the Jet Propulsion Laboratory selects award recipients for participation in this program. Selection is based on:

1. the quality of the proposed research or plan of study and its relevance to NASA programs;
2. the student's academic qualifications;
3. the student's ability to accomplish the defined research; and,
4. the proposed utilization of Center research facilities (for Center applicants only).

Proposal Preparation

New Applicants

First time applicants must submit an original and five copies of all application materials to the designated NASA Center or Enterprise Office. The appropriate NASA Headquarters Enterprise Office or Center Program Administrator must receive the complete package by February 1, 2002.

A complete package for ***new applicants*** must contain original signatures and be assembled in the following order:

APPLICATION MATERIALS—NEW APPLICANTS	COMMENTS
1. **Application/Proposal Cover Sheet—**The proposal cover sheet must be completed and signed by the student, faculty advisor, and university official responsible for committing the institution. Proposals will not be accepted without the required university approval signatures.	See Appendix A
2. **Abstract—**Proposal abstracts should concisely summarize the proposed research and its relationship to the NASA mission. The abstract should not exceed 100 words in length.	See Appendix B
3. Proposal/Project Description—A five-page proposal that is authored by the applicant must be included with the application package. The proposal should describe the student's proposed or ongoing research. The student and advisor must sign the proposal verifying that the student is the author.	
4. Transcripts—New applicants are required to submit an official transcript of all university activities (undergraduate and graduate) along with a short biographical sketch that includes past training, research, awards, scholarships, and other relevant accomplishments.	
5. **Budget**—Budgets must include cost estimates for student stipend, student allowance, and university allowance. Costs should be estimated for a twelve-month period. The student allowance can include tuition expenses and/or anticipated travel and living expenses for the student at a NASA facility. The university allowance may include estimates for student tuition, faculty advisor travel, or other expenses related to the student's research project. The budget must be prorated when the student anticipates a period less than 12 months.	See Appendix B
6. **Anticipated Use of Center Facilities and Resources**—Students competing for Center awards must indicate the NASA facilities and resources to be used in support of the research, including an estimate of any computer time required. Students are strongly encouraged to contact the appropriate NASA Technical Advisor listed for the proposed research area to coordinate these activities.	
7. **Letter of Recommendation**—The faculty advisor must provide a one-page letter of recommendation on behalf of the student. The letter must include a statement indicating the level of assistance provided to the student in the preparation of the GSRP proposal.	
8. **Background of Faculty Advisor and Student**—For new applications, the faculty advisor and the student must each submit a short biographical sketch (not to exceed two pages) that includes name, current position, title, department, university address, phone number, and principal publications.	

APPLICATION MATERIALS—NEW APPLICANTS	COMMENTS
9. **Certifications**—New students must obtain the signature of the authorizing official from the proposing institution for Certifications of Compliance. The signature is required at the bottom of the Application and Proposal Cover Sheet. For a review of the Certifications of Compliance required for this submission, please refer to the Appendices in this solicitation. Certifications of Compliance with Applicable Executive Orders and U.S. Code. (i) Privacy Act Statement (ii) Certification Regarding Debarment, Suspension, and Other Responsibility Matters, (iii) Certification Regarding Drug-Free Workplace Requirements, (iv) Certification Regarding Lobbying for Contracts, Grants, Loans, and (v) Assurance of Compliance with NASA Regulations Pursuant to Nondiscrimination in Federally Assisted Programs	See Appendix C

Renewal Applicants

Renewal applicants must submit an original and five copies of all application materials to the designated NASA Center or Enterprise Office. The appropriate NASA Headquarters Enterprise Office or Center Program Administrator must receive the complete package by February 1, 2002.

A complete package must contain original signatures and be assembled in the following order:

APPLICATION MATERIALS—RENEWAL APPLICANTS	COMMENTS
1. **Proposal Cover Sheet**—The proposal cover sheet must be completed and signed by the student, faculty advisor, and a university official responsible for committing the proposing institution. Proposals will not be accepted without the required university approval signatures.	See Appendix A
2. **Abstract**—Proposal abstracts should concisely summarize the ongoing research and its relationship to the NASA mission. The abstract should not exceed 100 words in length.	See Appendix B
3. **Research Progress Report**—A report that is authored by the applicant discussing the status of the research must be included with the application for renewal. It must report on progress made on the research investigation during the previous year of support, and that anticipated to be undertaken with renewal funding. This statement should not exceed five pages in length. Persons applying to NASA Centers must include a discussion of the planned use of research facilities and resources at the Center. The student and advisor must sign the progress report verifying that the student is the author.	
4. **Official Transcript**—Renewal applicants are required to submit official transcripts for all courses taken since the previously submitted application.	

APPLICATION MATERIAL COMPONENT—RENEWAL APPLICANTS	COMMENTS
5. **Budget**—Budgets must include cost estimates for student stipend, student allowance, and university allowance. Costs should be estimated for a twelve-month period. The student allowance may include tuition expenses and/or anticipated travel and living expenses for the student at a NASA facility. The university allowance may include estimates for student tuition, faculty advisor travel, or other expenses related to the student's research. The budget must be prorated when the student anticipates a period less than 12 months.	See Appendix B
6. **Anticipated Use of Center Research Facilities and Resources**—Students with Center awards must indicate the anticipated NASA facilities and resources to be used in support of the research, including an estimate of any computer time required. Students are strongly encouraged to contact the appropriate NASA Technical Advisor listed for the proposed research area to coordinate these activities.	

IV. GSRP RESEARCH AREAS FOR 2002

The following chart depicts awardee disciplines during the 2002 program. This is not an exclusive indication of the disciplines supported, but a quick reference to the array of academic areas associated with each NASA division. A detailed description of the research topic can be found on the Internet at http://education.nasa.gov/gsrp.

	Code S	Code U	Code Y	ARC	DFRC	GRC	GSFC	KSC	JPL	JSC	LaRC	MSFC	SSC
Aeronautical		■		■	■	■	■	■		■	■	■	
Chemical		■		■	■	■		■	■	■	■		■
Electrical			■		■	■	■	■	■	■	■		■
Mechanical		■			■	■	■	■		■	■	■	■
Metallurgy/ Materials				■		■				■	■	■	
Engineering		■	■	■	■	■	■	■	■	■	■	■	■
Astronomy	■			■			■		■				
Chemistry	■		■	■		■			■		■		
Physics	■	■	■	■		■	■	■	■		■	■	■
Physical Science	■	■	■	■			■		■			■	■
Mathematics		■		■				■			■		
Computer Sci.	■		■	■		■		■	■	■	■		■
Math/Comp	■			■		■	■	■	■		■		
Biological Science	■	■	■	■				■					■
Life Science		■		■				■	■	■			
Social Science		■		■								■	
Atm. Science	■		■	■			■		■		■	■	
Geol Science	■		■	■			■		■		■		■
Oceanography			■				■		■				■
Environmental Science		■	■	■			■					■	■
Psychology		■		■						■	■		
Other Sciences	■	■	■	■		■	■	■	■	■	■	■	■

CODE S	HQ Office of Space Science	**GRC**	Glenn Research Center	**LARC**	Langley Research Center
CODE U	HQ Office of Biological and Physical Research	**GSFC**	Goddard Space Flight Center	**MSFC**	Marshall Space Flight Center
CODE Y	HQ Office of Earth Sciences	**KSC**	Kennedy Space Center	**SSC**	Stennis Space Center
ARC	Ames Research Center	**JPL**	Jet Propulsion Laboratory		
DFRC	Dryden Flight Research Center	**JSC**	Johnson Space Center		

OFFICE OF SPACE SCIENCE (OSS)
(CODE S)

Program Administrator	**Mail OSS proposals to:**
Ms. Dolores Holland Office of Space Science Code S National Aeronautics and Space Administration Washington, DC 20546-0001 Phone: (202) 358-0734 Fax: (202) 358-3093 dolores.holland@hq.nasa.gov	Graduate Student Researchers Program-HQ OSS NASA Peer Review Services 500 E Street SW, Suite 200 Washington, DC 20024-2760 Phone: (202) 479-9030

The NASA Headquarters Office of Space Science (OSS) supports basic and applied research in space science. The OSS research program includes the development of major space flight missions such as the Space Infrared Telescope Facility and the Cassini Mission to Saturn, complementary laboratory research and analysis of data from prior missions, and theoretical studies.

The fundamental questions and goals for Space Science are given in the Space Science Enterprise Strategic Plan and can be accessed at the web site: http://www.hq.nasa.gov/office/codez/plans/SSE00plan.pdf. Proposers are reminded that a key criterion for proposal evaluation is the relevance of the proposed investigation to the NASA mission, as described in the science theme roadmaps in the Strategic Plan.

Within the Office of Space Science, activities are organized into four major and one cross-interdisciplinary theme areas:

- **Structure and Evolution of the Universe** — addressees cosmology, large-scale structure of the universe, evolution of stars and galaxies, including the Milky Way and objects with extreme physical conditions. Questions of interest are: What is the universe? How did it come into being? How does it work? What is its ultimate fate?

  Research in this theme is focused into campaigns targeted towards identification of dark matter and its influence on the shape of galaxies and clusters of galaxies; finding out where and when chemical elements were made; understanding of the cycles in which matter, energy, and magnetic field are exchanged between stars and interstellar gas; discovery of how gas flows in disks and formation of cosmic jets; identification of sources of gamma-ray bursts and high-energy cosmic rays; measurement of strong gravity near black holes and its affects on the early Universe.

- **Origins** — addresses the origins of galaxies, stars, protoplanetary disks, extra-solar planetary systems, Earth-like planets and the origin of life. Questions of interest are: How were galaxies born? How do stars and solar systems form? Are there other Earth-like planets?

  Research in this theme is focused on determining the fate of the baryonic matter; measuring the luminosities, forms, and environment of galaxies back to the epoch of their formation; trace the chemical evolution of the universe from the birth of the first stars; follow the journey of the heavy chemical elements after their birth to the formation of dust, new generations of stars and planetary systems; search for evidence of planet formation in disks around young stars; determine how planetary-system forming disks evolve; search for other planetary systems around a variety of stars and determine their characteristics; reconstruct the environmental history of Earth in the first billion years when life arose; characterize the traits of the universal common ancestor through phylogenetic analyses; characterize the range of atmospheric compositions that might be produced by microbal ecosystems; develop theoretical models for the compositional evolution of early Earth's atmosphere through to the accumulation of significant O_2; and to predict possible global biosignatures of planets around other stars.

- **Solar System Exploration** — addresses scientific activities that pertain to the solar system, including comets, and major and minor planets. Questions of interest are: What are the origin of the Sun, the Earth, and the planets, and how did they evolve? Did life evolve on other planetary bodies in the solar system? What are the ultimate fates of planetary systems? What threat is posed by the potential for collisions with Earth-approaching objects?

  Acceptable research topics include studies of the planets, rings, moons, comets, asteroids, meteorites, and cosmic dust. Areas of research interest include planetary geology and geophysics, materials and geochemistry, exobiology, planetary atmospheres, planetary astronomy, and planetary system science

- **The Sun-Earth Connection** — addresses the sphere of influence of the Sun on the Earth environment. Questions of interest are: What causes solar variability? How does the sun and its variability affect the Earth and other planets?

  Research in the Sun-Earth Connections theme focuses on investigations of the Sun, both as a nearby star and as a source of variable outputs of solar wind, energetic particles, and electromagnetic radiation with influence on the Earth and its space environment, on planetary and cometary magnetospheres, on the heliosphere, and on the local interstellar medium. The program involves investigations of the origin, evolution, and physics of plasmas, electromagnetic fields, and energetic particles in space. Studies of the terrestrial space environment include investigations of the coupling between the variable Sun and the Earth's magnetosphere, ionosphere, thermosphere, and mesosphere. Measurements are made from balloons, rockets, satellites, and deep space probes. Theory and computer simulations are also supported.

  Use of data is encouraged from NASA spacecraft, which include Polar, Wind, Geotail, ACE, FAST, SAMPEX, Yohkoh, SOHO, Cluster, and TRACE. The proposer should make clear that arrangements have been made to obtain the data.

- **Information Systems** — Information Systems research applies new developments in computer science and information technology to benefit space science endeavors. This includes a broad range of areas, including: science data management and archiving; software technology; data analysis, mining, and exploration; computational methods and algorithms; modeling, simulation and design; knowledge management and synthesis; collaborative environments; and autonomous systems.

The proposal should present a well-defined problem and justification of its scientific significance, as well as a detailed approach for its solution.

Research that exploits analysis of data collected by spacecraft-borne instruments, relevant ground-based data and laboratory experiments, and theoretical modeling is solicited. Emphasis is placed on the development and implementation of a multiwavelength program of space-based and suborbital missions (airborne, sounding rockets, balloons). Investigations that support instrumentation development relevant to future missions in the above areas, the analysis of data from ongoing and past missions, and laboratory and theoretical investigations that support the interpretation of relevant space-based observations are invited. Individuals are strongly encouraged to make their proposals directly relevant to the mission of the OSS science themes. In particular, recent successful proposals have concentrated on developing hardware or modeling tools and carrying out essential observations, specifically for particular NASA-supported missions.

OFFICE OF BIOLOGICAL AND PHYSICAL RESEARCH (OBPR) (CODE U)

Program Administrator	**Mail OBPR proposals to:**
Ms. Debra Spears Office of Biological and Physical Research Code UP NASA Headquarters Washington, DC 20546-0001 Phone: (202) 358-1952 Fax: (202) 358-4330 dspears@hq.nasa.gov	Graduate Student Research Program – HQ OBPR NASA Peer Review Services 500 E Street SW, Suite 200 Washington, DC 20024 Phone: (202) 479-9030

Physical Sciences

The Physical Sciences Division (PSD) promotes cross-disciplinary physical, chemical, and biological research. This research is managed within the following disciplines: Biomolecular Physics and Chemistry, Biotechnology, Combustion Science, Fluid Physics, Fundamental Physics, and Materials Science. Research sponsored by PSD uses the unique attributes of the space environment to advance scientific knowledge and technology, and uses advances in scientific knowledge to better understand the performance of technologies on Earth and in the unique environment of space. This includes ground-based experimental, theoretical, and computational research, predominantly conducted within colleges and universities; advanced technology development activities; and flight investigations conducted aboard the Space Shuttle and aboard the International Space Station.

Fundamental Space Biology

The Fundamental Space Biology Division supports research in cell and molecular biology, developmental biology, organismal and comparative biology, evolutionary biology, and gravitational ecology related to the space environment and microgravity. The programs include ground-based research technology development and flight investigations conducted aboard the Space Shuttle and aboard the International Space Station.

Bioastronautics Division

The Bioastronautics Division supports research in understanding the physiological and psychological adaptation to space flight, developing countermeasures to reduce the negative consequences of space flight in human health, and developing advanced human support technologies. The programs include ground-based research, technology development, and flight investigations conducted aboard the Space Shuttle, the International Space Station, and other space platforms.

OFFICE OF EARTH SCIENCE
(CODE Y)

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Program Description

Using the unique vantage points from space, aircraft, and in situ platforms, NASA's Earth Science Enterprise (ESE) is dedicated to developing a scientific understanding of the Earth system and its response to natural and human-induced changes to enable improved prediction of climate, weather, and natural hazards for present and future generations. The overarching question that strategically guides ESE research and development is:

How is the Earth changing and what are the consequences for life on Earth?

The key ESE research topics fall largely into three categories: forcings, responses, and the processes that link the two and provide feedback mechanisms. Specifically,

<u>How is the global Earth system changing?</u>

- Is the global cycle of water through the atmosphere accelerating?
- How is the global ocean circulation varying on climatic time scales?
- How are global ecosystems changing?
- How is stratospheric ozone changing, as the abundance of ozone-depleting chemicals decreases?
- Are polar ice sheets losing mass as a result of climate change?
- What are the motions of the Earth and the Earth's interior, and what information can be inferred about Earth's internal processes?

<u>What are the primary forcings of the Earth system?</u>

- What trends in atmospheric constituents and solar radiation are driving global climate?
- What are the changes in global land cover and land use, and what are their causes?
- How is the Earth's surface being transformed and how can such information be used to predict future changes?

<u>How does the Earth system respond to natural and human-induced changes?</u>

- What are the effects of clouds and surface hydrologic processes on climate change?
- How do ecosystems respond to environmental change and affect the global carbon cycle?
- Will climate variations induce major changes in the deep ocean?
- How do stratospheric trace constituents respond to climate change and chemical agents?
- Will changes in polar ice sheets cause a major change in global sea level?

- What are the effects of regional pollution on the global atmosphere, and the effects of global chemical and climate changes on regional air quality?

What are the consequences of change in the Earth system for human civilization?

- How are variations in local weather, precipitation and water resources related to global climate change?
- What are the consequences of land cover and land use change?
- To what extent are changes in coastal regions related to climate change and sea-level rise?

How well can we predict the changes to the Earth system that will take place in the future?

- To what extent can new global observations and advances in satellite date assimilation improve weather forecasting?
- To what extent can transient climate variations be understood and predicted?
- To what extent can long-term climate trends be assessed and predicted?
- To what extent can future atmospheric chemical impacts be assessed?
- To what extent can future atmospheric concentrations of carbon dioxide and methane be predicted?

The twenty-three science questions formulated above indicate the complexity of the global Earth environment, the multiplicity of interactions between component processes, and cross-disciplinary connections among them. In addressing these complex problems, the ESE supports both basic applied research that builds on the strength of the existing Earth science disciplines—generally focused on individual components of the Earth system, but provide a common language and the background knowledge for articulating focused science questions and suggesting productive research methodologies. The research themes are organized as follows:

- Biology and Biogeochemistry of Ecosystems and the Global Carbon cycle
- Atmospheric Chemistry, Aerosols, and Solar Radiation
- Global Water and Energy Cycle
- Oceans and Ice in the Earth System
- Solid Earth Science

Further details about the research strategy of the Earth Science Enterprise are available at http://www.earth.nasa.gov/visions/researchstrat/Research_Strategy.htm.

The Earth System Science (ESS) Fellowship Program, in support of the ESE Science Implementation Plan, funds both Master and Ph.D. applicants pursuing their graduate studies in the field of Earth system science. The financial support for the ESS Fellowships comes from both the Office of Earth Science and the Earth science portion of NASA's Graduate Student Researchers Program (GSRP) provided by the NASA Education Division.

Applications are considered for the research themes listed above and may be in atmospheric chemistry and physics, ocean biology and physics, ecosystem dynamics, hydrology, cryospheric processes, geology, geophysics, and information science and engineering, provided that the specific research topic is relevant to NASA's Earth remote sensing science, process studies, modeling and analysis in support of the U.S. Global Change Research Program (USGCRP). The Office of Earth Science discourages submission of paleo-climate or paleo-ecology related applications to this program. Proposals that address the molecular biology, biochemistry, development, physiology, or evolution of living organisms, but do not focus on ecosystems (terrestrial or marine) and their role in the Earth system functioning, should be submitted to other appropriate elements of this GSRP (e.g., Office of Biological and Physical Research, Office of Space Science, etc.) Additional information about the Earth Science Enterprise is available at http://www.earth.nasa.gov/.

Students admitted to or already enrolled in a full-time MS and/or Ph.D. program at accredited U.S. universities are eligible to apply. Students may enter the program at any time during their graduate work. Students may also apply in their senior year prior to receiving their baccalaureate degree, but must be admitted and enrolled in a MS and/or Ph.D. program at a U.S. university at the time of the award. United States citizens and resident aliens will be given preference, although the program is not restricted to them. Students with disabilities and from underrepresented minority groups are urged to apply. No applicant shall be denied consideration or appointment as a NASA Earth System Science fellow on grounds of race, creed, color, national origin, age, or sex.

The announcement for ESS Fellowship applications is made in mid-December each year, with proposals due in mid-March and selections made at the end of June of the following year. The announcement, including a detailed description of the submission procedure, is available under "Office of Earth Science" at http://research.hq.nasa.gov/.

AMES RESEARCH CENTER

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Mission

Ames is the NASA designated Center of Excellence for Information Technology and has Agency lead mission responsibility for Astrobiology, Aviation Operations Systems, and Aviation System Capacity. Other areas of research excellence include human factors, autonomous systems, nanotechnology and device modeling, high-performance computing and communications, gravitational biology, infrared astronomy, rotorcraft technology, and thermal protection systems. Ames is home to three national wind tunnel complexes (including the world's largest), several advanced flight simulators, supercomputers, arc jets, and a suite of centrifuges that serve as a national resource. Ames has unique resources for studying vertical takeoff aircraft in collaboration with the Army. The close juxtaposition with Silicon Valley and world-class universities make Ames a stimulating place to work.

In preparing a proposal for a fellowship at Ames Research Center, prior collaboration with an Ames researcher is mandatory. A suggested point of contact is listed with each research topic for which a student may apply.

AEROSPACE

Aerospace Technology — In aerospace, Ames concentrates on aviation systems including air traffic control and the simulation and modeling of aviation systems, thermal protection systems; runway independent aircraft technologies; integrated vehicle health management systems; systems analysis; and vehicle aeromechanics, controls, and crew interface systems.

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Air Traffic Management — Projected demands on the nation's air transportation system necessitate continued research to develop information systems and automation that will provide increased system capacity while maintaining safety. NASA is working to develop technology for the FAA and airspace users that enables more efficient air traffic management by predicting aircraft positions and conflicts so automated advisories can be generated to optimize schedules and resolve conflicts. The research also emphasizes human factors and advance display development to facilitate the human/automation systems interfaces.

Heinz Erzberger	(650) 604-5425	herzberger@mail.arc.nasa.gov

Modeling of Air Traffic Management System Concepts — Air traffic management systems globally are transitioning and changing in order to cope with the existing and predicted growth of the air transportation system. NASA is working to define alternative system-level concepts for the national air transportation system and to develop a simulation and modeling capability for design and tradeoff studies of these concepts. The research includes the development and validation of an integrated suite of air traffic system component models that include the airspace, varying levels of automation, and human performance. The research also emphasizes assessments of automation tools, concept elements such as traffic flow management and self-separation, and system-wide concepts.

Karlin Roth	(650) 604-6678	kroth@mail.arc.nasa.gov

Runway Independent Aircraft (RIA) Technologies — Effective response to the long-term demand for dramatic increases in air transportation (both passenger and cargo) requires the timely introduction of advanced aircraft configurations that are capable of making optimal use of airport infrastructure and land area. In collaboration with RIA operations, interest in this research area includes performance and control of new short take-off and landing vehicle concepts, integrated optimization of vehicle characteristics and operational procedures, safety with emphasis on take-off/climb and approach/landing, and environmental compatibility with emphasis on minimization of community noise. The approach to this research includes systems studies, computational modeling, and ground-based simulations.

Lawrence E. Olson	(650) 604-6681	lolson@arc.nasa.gov

Distributed Sensing — The use of wireless distributed embedded systems for measurement, analysis, and control of processes will form the basis of advanced transportation systems that exhibit exceptional levels of safety, robustness, and efficiency. In addition, such systems are required to support the development of advanced biologically based systems. Research is required to develop the required advanced sensor technology; techniques to power such systems; software for data processing, compression and fault detection; and communications, networks, and architectures.

James C. Ross	(650) 604-6722	jcross@arc.nasa.gov

Conceptual Design and Systems Analysis — The ability to develop new concepts and assess their overall characteristics from a systems point of view is essential to optimize the selection of new concepts for development to achieve the required levels of performance and to minimize life cycle costs. To achieve the desired level of fidelity, new conceptual design and systems analysis tools are required to account for broader range of disciplines being considered such as maintenance, safety, uncertainty, risk management, integrated system health management, and life cycle costs. In addition, research is required into the application of such systems analysis techniques to a larger spectrum of disciplines such as air traffic control and information technologies.

Mary Livingston	(650) 604-0148	mlivingston@arc.nasa.gov

Aircraft Controls and Displays — Design and evaluation of human-centered cockpit technologies for aircraft, flight control theory, control system design procedures and design tools, cockpit display and symbology design principles, guidance and navigation, vehicle and human performance modeling, simulation and flight investigations and demonstrations.

Jeffery Schroeder	(650) 604-4037	jschroeder@mail.arc.nasa.gov

Aeromechanics of Vertical Flight — Experimental and theoretical research programs to improve performance, vibration, and noise of advanced vertical flight aircraft. Studies include basic investigations of the aerodynamics, dynamics, and acoustics of rotor systems for helicopters, tilt rotors, and other advanced configurations. Experiments are performed in the Ames/Army 7x10-foot wind tunnel and in the National Full-Scale Aerodynamics Complex, which includes the 40x80-foot and 80x120-foot wind tunnels.

Gloria Yamauchi	(650) 604-6719	gyamauchi@mail.arc.nasa.gov

SPACE TECHNOLOGY

The work of Space Technology includes both research and development of devices and systems that will be needed on future space missions. Research areas range from the application of computer capabilities simulating the physical and chemical environment to the direct collection of physical and chemical data. Areas of technology development range from thermal protection during atmosphere entry, diagnostic measurements and instrumentation development for high enthalpy facilities, and reacting gas flow simulations.

Paul Wercinski	650-604-3157	pwercinski@mail.arc.nasa.gov

Aerothermodynamics — Provides aerothermodynamic flowfield computational capability to analyze and design advanced space transportation concepts including launch and planetary entry vehicles. Core capability in modeling arc-jet flow for high enthalpy ground testing and traceability to flight.

Dean Kontinos	(650) 604-4283	dkontinos@mail.arc.nasa.gov

Thermal Protection Materials and Systems — Develops lightweight, reusable ceramic Thermal Protection Systems (TPS) for transient, high-velocity atmospheric penetration and develops expendable TPS for planetary probes. Materials include ultrahigh temperature ceramics for leading edge applications, improved ceramic tiles, coatings, and high heat flux ablators for high speed Earth and planetary entry missions. Research is also carried out in self-healing TPS, rapid and reliable TPS inspection technology for Shuttle and future RLV's, and Superthermal insulation. The Branch develops and characterizes materials, and also fabricates flight hardware.

Sylvia Johnson	(650) 604-2646	smjohnson@mail.arc.nasa.gov

Integrated Tools for Aerothermodynamic Analysis to Support Thermal Protection System Design — Core capabilities in developing design tools, processes, and information for integration of high-fidelity modeling into the design process. Emphasis towards high end computing for simulation of high enthalpy flows and development of methods for leveraging multiple simulations to generate design information.

Dean Kontinos	(650) 604-4283	dkontinos@mail.arc.nasa.gov

High Enthalpy Flow Instrumentation Development — Performance of research of new instrumentation measurements devices for use in high enthalpy arc jet facilities. Devices would measure conditions relevant to determination of the operations of the facilities, the facility aerothermal environments, or the response and interaction with test articles in the facility.

Joe Hartman	650-604-5269	jhartman@mail.arc.nasa.gov

Computational Chemistry — Application of molecular structure, molecular dynamics and molecular modeling techniques to a wide range of problems of NASA interest. Current research activities are focused on nanotechnology, device modeling high-energy density materials, combustion research, polymers, astrophysics, aerothermodynamics, and atmospheric chemistry. Specifically, we are interested in computing accurate thermodynamic properties, vibrational frequencies and intensities, molecular line strengths, reaction rates, electron-molecule cross sections, transport properties and spectroscopic constants. We are also interested in porting and extending code for current and next generation parallel architectures.

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Applied Computational Fluid Dynamics — This area deals with the development of new computational methodology and tools involving aerodynamic and/or fluid dynamic application associated with incompressible, subsonic, transonic, and supersonic speeds. Computational tools are constructed and evaluated for applications associated with steady and unsteady flows, flows with aeroelastic effects, and optimization. Computational flow simulation codes are integrated with information technology tools to provide capability for high-fidelity analysis involving development of aircraft and/or spacecraft components and systems.

Dochan Kwak	(650) 604-6743	dkwak@mail.arc.nasa.gov

Turbulence Physics — Study of the fundamental physics of turbulent and transitional flows through numerical simulations and experiments. Studies include developing numerical algorithms suitable for direct and large-eddy simulations of turbulent flows, developing tools for analyzing computer-generated, databases, developing turbulence models for engineering applications, and performing experiments to understand flow physics and support turbulence model validation.

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INFORMATION SCIENCES AND TECHNOLOGY

As the Center of Excellence for Information Technology (COE-IT), Ames' primary mission is to provide strategic research focus and agency-level coordination of NASA's investment in advanced information technology. Ames' role is to pioneer and lead the research, development, and implementation of information technologies to support NASA's Aerospace Enterprise and missions. In support of the four NASA Strategic Enterprises — Aerospace, Space Science, Human Exploration and Development of Space, and Mission to Planet Earth — five information technology focus areas have been identified: Integrated Design Systems; Large-Scale Information Management and Simulation; Aviation Operations; Space Systems Operations; and Autonomous Systems for Space Flight.

Systems Health and Safety — The primary focus of this research is to demonstrate information processing algorithms of a generic nature that may be used in next generation aerospace vehicles to detect, isolate, or rectify imminent or foreseeable component malfunctions. This work will be explored within the framework of advanced avionics architectures to improve aircrew caution/warning advisories, provide input to onboard adaptive flight/propulsion control systems, or trigger on-condition ground maintenance. The coordinated technical efforts involved include: model-based signal analysis, machine pattern classification, multivariate sensor fusion, testability analysis, multi-signal modeling, flowgraph analysis, damage trajectory modeling, optimal decision-making, design analysis, and manufacturing variations.

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Ann Patterson-Hine	(650) 604-4178	apatterson-hine@mail.arc.nasa.gov

Intelligent Flight Control — The objective of this research is to develop next generation neural flight controllers using enhanced neural network algorithms and adaptive control technologies. These controllers will be developed to exhibit higher levels of adaptability than current state-of-the-art systems for the purpose of automatically compensating for a broader spectrum of damage or failures, controlling remote or autonomous vehicles, and reducing costs associated with flight control law development.

Karen Gundy-Burlet	(650) 604-4475	kgundyburlet@mail.arc.nasa.gov

Information Physics — The objectives of this research are to explore new insights into physical laws that may be gained by adopting a viewpoint of 'information' and 'computation' in analyzing experiments, as well as the design and analysis of information storage, processing, and transmission systems that must be carried out within the framework of physical laws. Work in this area is designed to explore and exploit the fundamental relationships between physics and information along both of these avenues. In both of these endeavors, the ultimate goal is to meet future mission needs for advanced technologies capable of handling extremely difficult information storage and processing tasks by a minimum expenditure of physical resources.

Dogan Timucin	(650) 604-1262	timucin@ptolemy.arc.nasa.gov

Artificial Intelligence — Basic and applied research is conducted in the framework of aerospace domains including space transportation, space science, and aerospace. Three research areas are emphasized: Planning (including both goal- and resource-driven approaches); machine learning (entire spectrum from empirical to knowledge-intensive); and the design of and reasoning about large-scale physical systems (including work in knowledge acquisition, knowledge base maintenance, and all applications to the design process).

Mark Shirley	(650) 604-3389	shirley@ptolemy.arc.nasa.gov

Applied Information Technology — As an expert center for computer security and workgroup/workflow, Ames will play a considerable role in developing and integrating the "Office of the Future" into the NASA environment. Taking advanced technologies from Ames' Information Technology Center of Excellence and from industry, engineers and computer scientists will adapt these concepts to desktops throughout the Agency.

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Information Power Grid—This research is directed toward a wide-area, heterogeneous, high performance computing, communications, and data environment for aerospace applications. Includes architecting seamless grids of high-end resources, scheduling, programming services, problem solving environments, metadirectories, and multiauthority security for a scalable infrastructure of services.

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Neuroelectric Technologies for Augmented Human-System Interaction — Neuroelectric technologies will add completely new modes of interaction that operate in parallel with keyboards, speech, or other manual controls, thereby increasing the bandwidth of human-system interaction. Current research is focused on brain-computer interface development using electroencephalographic (EEG) methods, which bypass muscle activity and draw control signals directly from the human nervous system. A second focus lies in human performance optimization. This work includes estimation or prediction of human perception and performance from electrical measures of brain function such as event-related potentials. In both areas, there is a strong emphasis on the development of new methods for biomedical signal processing (See the Web site: http://vision.arc.nasa.gov/~ltrejo).

Leonard Trejo	(650) 604-2187	ltrejo@mail.arc.nasa.gov

HUMAN FACTORS

Crew performance, aviation safety, aircraft operating systems advanced spatial displays and instruments, virtual environments, high-fidelity simulation-based human performance assessment, operator interfaces to intelligent systems and advanced automation.

Human Performance Modeling — The Cognition Laboratory conducts research into human cognition and information processing with the goal of improving operator performance and operational safety. Research concentrates on aerospace applications such as air traffic control and launch operations. Field and laboratory studies are integrated into computational models of the human operator that predict performance in complex dynamic environments. We have developed a computational architecture, Apex that simulates operator multitasking behavior and provides support for building models of human cognition.

Roger Remington	(650) 604-6243	rremington@mail.arc.nasa.gov

Virtual Environments — Research is conducted on the physiological and psychological phenomena that constrain human performance in virtual environment and augmented environments (see-through head mounted displays). Emphasis is placed on operator interaction with virtual objects and improving the perceptual and motor fidelity through geometric, dynamic and symbolic enhancement of the computer graphics, which are used to produce the virtual environments and virtual objects. (See the Web site: http://duchamp.arc.nasa.gov/adsp.html).

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Spatial Auditory Displays — The NASA Ames Spatial Auditory Displays Laboratory conducts basic and applied research in spatial auditory perception and localization with the goal of successfully implementing virtual acoustic displays for improved operator efficiency and safety in aerospace applications. The Lab's work is also concerned with the human factors of auditory displays in general, including speech communications systems, non-speech warnings and information displays (http://duchamp.arc.nasa.gov/adsp.html)

Elizabeth Wenzel	(650) 604-6290	bwenzel@mail.arc.nasa.gov

Visual Displays for Aerospace — NASA Ames Research Center is investigating displays for cockpit situational awareness, with the intention of assisting the implementation of free flight. This work is in to the RTCA Task Force 3 Report on Free Flight Implementation, which identified cockpit situational awareness displays as a key component of the next generation air traffic management (ATM) system. This report states "The architecture and technology on which the emerging ATM system is based makes increasingly heavy use of new displays that provide flight crews with real time situational awareness." Therefore, the RTCA report recommends the immediate initiation of "the development of standards for a cockpit situational awareness display of traffic information (CDTI)." Determining these standards requires a detailed human factors evaluation, where the nature and format of the displayed information are examined. The Cockpit Situational Display Research Team has been assigned to assess this task (http://www-cdti.arc.nasa.gov/).

Walter Johnson	(650) 604-3667	wjohnson@mail.arc.nasa.gov

Vision Science — Experimental and theoretical research on human vision and applications of this research to coding, analysis, and display of visual information (http://vision.arc.nasa.gov).

Andrew Watson	(650) 604-5419	abwatson@mail.arc.nasa.gov

Image Processing — Basic and applied research on computational algorithms for automatically extracting information from still images and video data. Current projects in the computational vision laboratory at Ames Research Center include automatic detection of air traffic using airborne cameras, locating features in close-up images of the human eye for movement tracking, and computational assessment of the visual quality of coded or compressed images. These and other applications employ fundamental image processing techniques such as spatial and temporal filtering, registration, and warping (http://vision.arc.nasa.gov).

Jeffrey Mulligan	(650) 604-3745	jmulligan@mail.arc.nasa.gov

ASTROBIOLOGY AND SPACE RESEARCH

The Astrobiology and Space Research Directorate at Ames manages activities in research and technology development in support of NASA's space programs. Work is done in Space Sciences, Life Sciences, and Earth Sciences; in addition, programs are conducted in Space Flight Projects.

SPACE SCIENCES

In space sciences, Ames concentrates on research directed at enhancing understanding of the origins, evolution, and current state of the universe. Principal efforts focus on a multidisciplinary approach to research activities, the development and application of selected flight projects, and areas of technology development relevant to those research needs.

Infrared Astronomy Projects and Technology Development — Current research is focused on the integration of the design tools to allow full system simulation prior to SOFIA operation. The technology tasks include IR detectors and cryogenics. Multi-element IR detector arrays are developed and characterized for space astronomy. Advanced efficiency cooling techniques are developed for space.

Chris Wiltsee	(650) 604-5917	cwiltsee@mail.arc.nasa.gov

Infrared Observational Astronomy and Instrumentation — Young stars, circumstellar disks, and the interstellar medium are being studied with observations conducted from ground- and space-based observatories. These data are interpreted in collaboration with Ames theorists and laboratory astrochemists. Advanced infrared instruments are also being studied and developed for use on SOFIA, the Next Generation Space Telescope, and other NASA observatories.

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Theoretical Astrophysics — Research is being conducted on star formation, circumstellar disks, the physics and chemistry of the interstellar medium, and the formation and dynamical evolution of galaxies. Theoretical models involve the application of computational techniques to problems in astrophysical gas dynamics, radioactive transfer, and many-body systems.

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Planetary Science — Research in this area focuses on objects in our solar system—the atmospheres, surfaces, and rings of both terrestrial and gas giant planets and their satellites. Spacecraft and ground-based observations and theoretical modeling are being conducted.

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Rich Young (planetary atmospheres)	(650) 604-5521	reyoung@mail.arc.nasa.gov

The wealth of information returned by the Galileo, Cassini, and Mars Global Surveyor spacecraft continues to advance theories of surface formation and evolution. Our research focuses on the geomorphological evidence for processes which have shaped the surfaces and interiors of solid bodies over the age of the solar system. Comparative studies of planetary systems are utilized to understand the geological histories and petrology of icy bodies (Europa, Ganymede, Callisto, Triton, Pluto/Charon) and other planets (Mars, etc.). Geochemical and geophysical modeling of the internal processes shaping the surfaces of Mars, the Galilean and Saturnian satellites, and other objects are combined with remotely sensed data sets to provide qualitative and quantitative understanding of the forces which shaped these worlds.

Jeff Moore (planetary surfaces)	(650) 604-5529	jmoore@mail.arc.nasa.gov

Exobiology — Interdisciplinary research in planetary biology is aimed at understanding the factors in cosmic, solar system, and planetary development that have influenced the origin, distribution, and evolution of life in the universe and the course of interaction between biota and Earth's surface environments.

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Chris McKay	(650) 604-6864	cmckay@mail.arc.nasa.gov

Planet Formation and Detection of Extrasolar Planets — Several aspects of planetary growth are being modeled: Agglomeration of dust into planetesimals; dynamical interactions of planetesimals and their accretion into terrestrial planets and giant planet cores; and accumulation of giant planet atmospheres. Planets around other stars are being searched for using the photometric (transit) and Doppler (radial velocity) techniques.

Jack Lissauer (planetary dynamics, planetary detection)	(650) 604-2293	lissauer@ringside.arc.nasa.gov
Jeff Cuzzi (accretion of planetesimals)	(650) 604-6343	jcuzzi@mail.arc.nasa.gov
Kevin Zahnle (evolution of planetary atmospheres, impacts)	(650) 604-0840	kzahnle@mail.arc.nasa.gov

Astronomical Data Analysis — Development of new analysis methods for time series and other data streams from NASA's Great Observatories, including high-energy missions such as gamma-ray and x-ray telescopes. The new algorithms under study include wavelet methods, time frequency distributions, Bayesian statistics and related methods (including implementation of Markov Chain Monte Carlo integrations). In addition, simulations of the dynamical systems thought to underlie the astronomical objects and their luminosity variability are highly informative.

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LIFE SCIENCES

In life sciences, Ames concentrates on fundamental space biology (the effect of gravity on living systems from cells through humans) and biomedicine (the effects of the space environment on man and other organisms).

Space Biology — Space biology research uses the space environment, particularly weightlessness, and ground-based space flight simulations to investigate basic scientific questions about the role of gravity in present-day terrestrial biology. The research is divided into the disciplinary areas of biological adaptation, gravity sensing, and developmental biology. Experiments are carried out at the subcellular, cellular, tissue, organ, and system levels in differing organisms.

Ruth Globus	(650) 604-5247	rglobus@mail.arc.nasa.gov

Neurosciences — Research in neurosciences examines how the nervous system adapts to environmental conditions encountered in space, how adaptive processes can be facilitated, and how human productivity and reliability can be enhanced. To elucidate mechanisms underlying adaptation, neurosciences research includes neurochemistry, neuroanatomy, neurophysiology, vestibular physiology, psychophysiology, and experimental and physiological psychology. State-of-the-art facilities include: human and animal centrifuges, linear motion devices, an animal care facility, a human bed-rest facility, and NASA's Vestibular Research Facility.

Malcolm Cohen	(650) 604-6441	mmcohen@mail.arc.nasa.gov

Space Physiology — Multidisciplinary research in space physiology emphasizes the effects of hypergravity, gravity and microgravity on cardiovascular, musculoskeletal, and regulatory systems of humans and animals. Actual microgravity and ground-based models of simulated microgravity are used to investigate basic mechanisms of adaptation to space and readaptation to Earth. Physiological, biomechanical, cellular, and biochemical factors are also studied to develop appropriate countermeasures for maintaining health, well-being, and performance of humans in space.

Charles Wade	(650) 604-3943	cwade@mail.arc.nasa.gov

Life Support — Research is conducted in the broad area of regenerative life support for space: the conservation and reuse of materials consumed by space crews. Issues of interest include the use of physical and chemical devices for air regeneration, water purification, waste management and oxidation and atmosphere contaminant control. Also of interest are systems control, systems modeling and simulation, and the potential role of biological systems in life support supplementation.

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EARTH SCIENCE

In Earth Science, the focus at Ames is to perform and lead research within the disciplines of atmospheric and ecosystem science, with particular emphasis on how the biosphere and atmosphere interact to influence the evolution of the global system on all time scales.

Atmospheric Physics — Research in this area advances the scientific knowledge and understanding of the physical processes that determine the behavior of the atmosphere on Earth and other solar system bodies. Experimental and theoretical research is conducted in the areas of aerosol and cloud microphysics, atmospheric modeling, atmospheric radiation, and high-resolution infrared spectroscopy with the main focus on current environment and climatic issues. By utilizing cutting-edge and information technologies and unique instrumentation, research techniques are developed to implement these research goals.

Warren Gore	(650) 604-5533	wgore@mail.arc.nasa.gov

Ecosystem Science and Technology — Interdisciplinary research in ecosystem science and technology looks at the role of life in modulating the complex cycling of materials and energy throughout the biosphere. Intact ecosystems, with particular emphasis on temperate and tropical forests, are examined by remote sensing from aircraft and spacecraft and by field site visits, with subsequent laboratory and computer analysis of the data gathered.

James A. Brass	(650) 604-5232	jbrass@mail.arc.nasa.gov

Earth Atmospheric Chemistry and Dynamics — Research in this area includes the development of models and the use of airborne platforms and spacecraft to study chemical and transport processes that determine atmospheric composition, dynamics, and climate. These processes include the effects of natural and man-made perturbations.

Steve Hipskind	(650) 604-5076	shipskind@mail.arc.nasa.gov

Ecosystem Science — Research in this area is directed to advanced understanding of the physical and chemical processes of biogeochemical cycling and ecosystem dynamics of terrestrial and aquatic ecosystems through the utilization of aerospace technology.

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DRYDEN FLIGHT RESEARCH CENTER

Program Administrator
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Mission

- Conduct safe and timely flight research and aircraft operations for current and future aerospace vehicles.
- Conduct atmospheric flight operations for NASA science platform aircraft.
- Support development and operations for Shuttle and future access-to-space vehicles.
- Enhance competitiveness to United States aerospace industry.

The Dryden Flight Research Center program includes most engineering disciplines in aeronautics with emphasis on flight systems integration and flight dynamics. The following descriptions identify the current activities relevant to the Dryden program for which qualified students may apply.

Advanced Digital Flight Control — Modeling, simulation, and flight testing of distributed control systems. Design criteria and methods for unconventional vehicles, including decoupling of asymmetrical airplanes and stabilization of highly unstable airframes.

Robert Clarke	(661) 276-3799

Flight Systems — Engineering aspects of the formulation, design, development, fabrication, evaluation, and calibration of flight control, avionic, and instrumentation systems used onboard complex, highly integrated flight research vehicles. Work with fault tolerant redundant microprocessor-based control systems, microprocessor-based measurement systems, transducers, actuators, techniques for system safety, and hazard analysis.

Bradley Flick	(661) 276-3769

Flight Dynamics — Pilot/aircraft interaction with advanced control systems and displays, assessing and predicting aircraft controllability, developing flying qualities criteria, parameter estimation, and mathematical model structure determination.

Robert Clarke	(661) 276-3799

Flight Test Measurement and Instrumentation — Flow measurement, skin friction drag, fuel flow, integrated vehicle motion measurements, space positioning, airframe deflection, sensor and transducer miniaturization, and digital data processing.

Rodney Bogue	(661) 276-3193

Fluid Mechanics and Physics — Laminar and turbulent drag reduction configuration aerodynamics, experimental methods, wing/body aerodynamics, full-scale Reynolds number test technology, high angle of attack aerodynamics, applied mathematics, and atmospheric processes.

Robert Curry	(661) 276-3715

Propulsion/Performance — Propulsion controls, integrated propulsion/airframe systems, and vehicle performance measurement.

Ronald Ray	(661) 276-3687

Structural Dynamics — Vibration and flutter prediction by finite element based aeroelastic and aeroservoelastic analysis, aircraft flutter, flight envelope expansion, ground vibration and inertia testing, active control of structural resonances, and advanced flight test technique development.

Mike Kehoe	(661) 276-3708
Martin Brenner	(661) 276-3793

Aircraft Automation — Knowledge-based systems development, verification and validation of knowledge-based systems, neural networks, heuristic controllers, knowledge-based acquisition/ implementation, maneuver controllers, performance optimization, guidance, pilot-vehicle interface, and robotic aircraft.

Patrick Stoliker	(661) 276-2706

Integrated Test Systems and Aircraft Simulation — Development of Integrated System Test equipment, including aircraft/simulation interface equipment, automated test equipment, and applied artificial intelligence techniques for diagnosis and control. Flight simulation development for advanced aircraft systems in aerodynamic, propulsion, and flight control modeling.

Robert Binkley	(661) 276-3776

GLENN RESEARCH CENTER

Program Administrator
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Mission

Within NASA, Glenn Research Center is designated as the lead Center for Aeropropulsion. In this capacity it is Glenn's role is to develop, verify, and transfer aeropropulsion technologies to U.S. industry. Glenn is also designated a Center of Excellence in Turbomachinery. The role here is to develop new and innovative turbomachinery technology to improve the reliability and performance, efficiency and affordability, capacity and environmental compatibility of future aeronautical and space propulsion systems. Other Glenn activities include a broad array of research and technology development efforts in the areas of aeronautical propulsion, space propulsion and power, space communications, and microgravity science relating to combustion and fluid physics. Brief descriptions of some of the major research activities at Glenn follow.

PROPULSION SYSTEMS ANALYSIS OFFICE

Propulsion Systems Analysis — Advanced propulsion system concepts are conceived and analyzed to estimate performance for typical and advanced, futuristic flight vehicle applications, determine relative merits compared with present and future proposed alternative propulsion systems, and derive optimum designs of systems integrated with a vehicle. Also, analytical and numerical models that predict performance, noise, weight and cost of complete propulsion systems, components and technologies are developed, along with models of flight vehicles.

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COMPUTING AND INTERDISCIPLINARY SYSTEMS OFFICE

Computing, Information, and Communication Technologies — The rising cost of developing propulsion systems is causing a strong demand for minimizing cost while still meeting the challenging goals for improved product performance, efficiency, emissions and reliability. Computational simulations represent a great opportunity for reducing design and development costs by replacing some of the large scale testing currently required for product development. NASA personnel are interested in computational simulations because of the potential for fielding improved propulsion systems with lower development cost, greater fuel efficiency and greater performance and reliability. A greater use of simulations would not only save some of the costs directly associated with testing, but also enable design trade-offs to be studied in detail early in the design process before a commitment to a design is made. A detailed computational simulation of an engine could potentially save up to 50% in development time and cost.

NASA Glenn Research Center (GRC) is developing an environment for the analysis and design of propulsion engines called the Numerical Propulsion System Simulation (NPSS). One of the goals for NPSS is to create a "numerical test cell" enabling full engine simulations overnight on high performance computing platforms. In order to achieve this goal, NASA personnel at the GRC have been involved since the early 1990s in applying cluster-computing technology to solving aeropropulsion problems.

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INSTRUMENTATION AND CONTROLS TECHNOLOGY

Advanced Sensors, Electronics and MEMS/Nano Technology — Research and development in advanced smart sensing concepts, sensor and biosensor technology, high temperature electronics materials and devices, MEMS and nanofabrication, integration and applications. Emphasis is on developing advanced capabilities for measurement and control of harsh aerospace propulsion systems. Specific areas of work include extreme high temperature sensors for surface temperature, strain and microcrack measurements, pressure sensors, remote temperature sensors, heat flux gages, chemical species sensors, silicon carbide crystal growth, modeling, and all areas of electronic device fabrication technology, MEMS micromachining, micro- and nanofabrication, microsystem integration, testing and harsh environment application (see http://www.grc.nasa.gov/WWW/sensors/SENSORS.HTM).

Lawrence G. Matus	(216) 433-3650	Lawrence.G.Matus@grc.nasa.gov

Optical Measurement Systems — Research and development of optical instrumentation technology for aerospace propulsion and power testing, for propulsion system control and for space experiments. This technology includes laser-based imaging techniques, micro-optics, sensor webs, quantum mechanics, nanotechnology and biomimetics. New systems for both high spatial resolution and high temporal resolution of parameters such as velocity, temperature, pressure, damage and species concentration are conceived and developed in the division's laboratories and applied in Center research facilities (see www.grc.nasa.gov/WWW/OptInstr).

Carolyn R. Mercer	(216) 433-3411	Carolyn.R.Mercer@grc.nasa.gov

Controls and Dynamics Technology — Development and demonstration of technologies for advanced control concepts, health management, and dynamic modeling that enhance performance, safety, environmental compatibility, reliability and durability of aerospace propulsion systems. Specific areas of controls research include fault diagnostics, health management, active combustion control, active stall control, turbomachinery system stability management, intelligent engine control, integrated flight/propulsion control, nonlinear and robust multivariable control synthesis techniques, and life extending control. Dynamic modeling research is focused on advanced propulsion concepts and components including turbomachinery, pulse detonation engines, and high-speed inlets (see http://www.grc.nasa.gov/WWW/cdtb).

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MATERIALS

Ceramic-Matrix Composites — Development of structure/processing/property relationships of ceramic-matrix composites including fibers and fiber coatings for high-temperature, high-reliability requirements for advanced aerospace propulsion and power applications (e.g., SiC/SiC, C/SiC, and oxide/oxide). Various processing approaches, including polymer pyrolysis, melt infiltration, and sol-gel processing, are being pursued. Properties of interest include interface stability flaw distribution, phase morphology, strength, toughness, crack initiation and propagation characteristics, and resistance to environmental attack. In addition, novel approaches for ceramic toughening, such as interpenetrating networks, are being pursued by conventional ceramic processing and crystal growth. Applications include various hot section components for aircraft and rocket engines, zirconia fuel cells and high temperature piezoelectrics.

Serene Farmer	(216) 433-3289	Serene.C.Farmer@grc.nasa.gov

Environmental Durability of Advanced Materials — Research studies are conducted to investigate the mechanisms of degradation and to establish and predict the thermochemical stability limits for advanced materials in the high and ultrahigh temperature, hostile environments encountered in advanced aerospace propulsion and power systems. Oxidation, corrosion, diffusion, erosion, wear and material compatibility of metals, ceramics, polymers and composite materials are studied in air, inert and simulated aerospace environments, under both isothermal and cyclic conditions. Various testing and characterization approaches, at the laboratory and subcomponent scale, are used to evaluate performance and guide the development of the materials and protective coatings to improve durability, through extension of useful life and/or maximum use-temperature. Barrier coatings are frequently required to protect the structural material from life-limiting degradation effects induced by thermal, environmental, diffusion, and/or erosion and wear issues, of the targeted application(s). The coatings are typically deposited as overlays, via plasma spray, vapor deposition techniques, or by using solution-based methods. Also, coatings produced by a wide variety of other techniques are typically evaluated and characterized for their protective ability. Environmental life prediction and process modeling is an important component of this work. The research area is interdisciplinary by nature, involving high temperature chemistry, physics, materials science, mathematics, as well as chemical, mechanical, and materials engineering

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Metallic Materials — Development of structural metallic materials for aerospace propulsion systems. Intermetallic compounds, superalloys, copper alloys, aluminum alloys and composites are being studied for improved performance, higher temperatures, greater durability, and lower cost. Microstructure/property relationships are being developed and experimentally verified. Advanced analytical and microscopy techniques are employed.

Michael V. Nathal	(216) 433-9516	Michael.V.Nathal@grc.nasa.gov

Polymers and Polymer Matrix Composites — Development of advanced polymers and polymer matrix composites for use in aerospace propulsion and power and space transportation systems. Areas of research include polymer synthesis, characterization, and processing (including thermal and radiation curing); composite processing, characterization and evaluation; interface studies; polymer/composite aging and life prediction; determination of structure/property relationships; and the application of nanotechnology and biotechnology in the development of new organic/polymeric materials. Research is interdisciplinary and involves work in organic and polymer chemistry, physics, chemical engineering, materials science and engineering, and mechanical engineering.

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MICROGRAVITY SCIENCE

Combustion Science, Fluid Physics and Transport Phenomena, and Space-Based Processes — Basic science investigations devised to utilize microgravity environment of space to gain new insight in the areas of combustion science, fluid physics and transport phenomena, and space-based process research. NASA Lewis Research Center has a world-class and unique suite of ground-based microgravity research facilities that include: a 2.2-second drop tower, a 5-second zero-gravity facility, and a reduced-gravity aircraft. These facilities are utilized to conduct microgravity research and to develop space flight experiments for longer duration microgravity experiments conducted on the Space Shuttle and planned for the International Space Station. Well-equipped state-of-the-art laboratories are used to develop new diagnostic techniques/instruments especially suited for use in microgravity research on Earth as well as in space. The experiments conducted in space provide new knowledge that is used to improve processes and equipment used on Earth as well as for exploration of space.

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POWER AND ON-BOARD PROPULSION TECHNOLOGY

Electrochemical Systems — Development of advanced technology to increase the life and energy density of energy storage systems and fuel cells. Emphasis is on near-term lithium-based systems and hydrogen-oxygen primary and regenerative fuel cell systems, with exploratory efforts being given to more advanced high-temperature ionic conductor systems. Pre-prototypes of advanced battery systems are being designed, built and tested. Performs system design, modeling and analysis of advanced electrochemical systems.

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On-Board Propulsion — Research and development efforts on high performance electric and chemical propulsion system concepts that are candidates for applications ranging from precision positioning of microspacecraft to primary propulsion for planetary exploration. For electric propulsion, electrothermal, electromagnetic, and electrostatic thruster systems are considered with an emphasis on miniaturization for 21st-century missions. The low thrust chemical effort focuses on high performance storable bipropellant engines, green monopropellant and bipropellant systems, and miniaturized systems for microspacecraft. Efforts range from basic research to focused development.

In addition to thruster system development, heavy emphasis is placed on the identification and resolution of integration issues critical to the user community.

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Photovoltaic Cells — Fundamental and applied research to increase the efficiency, reduce the weight, and extend the life of solar cells for space applications. Emphasis is on III-V compound solar cells, high bandgap materials, and thin film materials. Activities include chemical processing and deposition; materials studies; investigations of radiation damage effects; device design, fabrication, and testing; and the development of related component technologies such as cell contact metallurgy and optical concentrators.

Roshanak Hakimzadeh	(216) 433-8738	Roshanak.Hakimzadeh@grc.nasa.gov

Power Systems Surfaces and Materials Technology — Development of new or improved environmentally durable power materials, high emittance radiator surfaces, high reflectance or transmittance solar concentrators, high thermal conductivity materials and high electrical conductivity composites. Power materials and surfaces are developed by means of intercalation techniques, surface modification technology, and development of thin film protective coatings using various deposition techniques. Evaluations of functional performance and durability are conducted for exposure to atomic oxygen, ultraviolet radiation, vacuum thermal cycling.

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Space Solar Arrays — Development of advanced planar and concentrator array technologies, components, and concepts for small spacecraft that are efficient, stowable, lightweight, long-lived, and less costly than present systems. Array design features of interest include optical, electrical, thermal, and mechanical elements. Test, analysis and development activities can also support large spacecraft arrays including structural analysis of deployment mechanisms, testing system operation in simulated space environments, and studies of new array concepts.

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Space Environmental Interactions — Research on radiation damage and electrostatic and electromagnetic effects in space systems and instrumentation (induced by interaction with space plasma and field environments) and on the characterization of local plasma and field environments around large space systems. Effects include surface and bulk dielectric charging, plasma sheath development, current collection from plasma, arcing, and the stimulation and propagation of disturbances. Research disciplines: plasma, solid-state, and surface physics, electromagnetism, and space system design fundamentals, and development of computer programs for simulation and modeling of spacecraft environment interactions.

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Space Power Management and Distribution Technology — Research and technology development to control the generation and distribution of electrical energy in aerospace systems and to define enabling technology for future aerospace power systems. Technologies being pursued include the development of intelligent modular converter technologies using semiconductor power electronic building blocks and advanced digital signal processors to facilitate the development of plug and play power systems. Furthermore, advanced magnetics and capacitor technology are being investigated along with silicon carbide semiconductor to enhance the overall converter power density and operating temperature range. In addition, work is also being done on high voltage space power systems including switchgear and converters to move to higher power space systems. These technologies will provide the foundation for the next generation of power distribution systems and advanced motor drives for future actuation and flywheel systems for aerospace application. Finally, some work is being done in the Integrated Vehicle Health Monitoring (IVHM) to utilize advanced automation techniques to detect and correct faults within the power management and distribution system.

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Thermo-Mechanical Systems Technologies — Develop technologies for high efficiency conversion of thermal energy (solar or nuclear) to electric power and thermal management. Emphasis on advances in free-piston Stirling power conversion and associated subsystems such as thermal transport and electric controllers. Stirling application is intended to be conversion of heat from isotope for deep space applications and Mars rovers, although solar applications are of interest. Also have effort in Brayton cycle conversion technology for space-based applications. Optical technologies include solar inflatable solar concentrators and an advanced refractive secondary concentrator. Thermal management involves the theoretical and experimental feasibility study of advanced lightweight survivable, deployable radiator concepts, advanced high performance technologies to cool electronics, thus providing high-density packaging and advanced cooling and refrigerator/freezer systems. Systems analysis to guide the advanced space power technologies and to support mission planning through the Virtual Design Centers is also conducted.

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SPACE COMMUNICATIONS TECHNOLOGY

Applied RF Technology — Research and advanced development of phased arrays for space communication systems in support of NASA missions and commercial applications. Emphasis is on development of K- and Ka-band arrays and array feeds in which distributed Monolithic Microwave Integrated Circuit (MMIC) devices provide amplitude and phase weighting; but alternate, potentially lower cost space-fed active array approaches are also of interest. Principal thrusts are on MMIC integration technologies, including MMIC packaging; printed circuit radiating elements and distribution media, beam forming/combining networks and fiber optic links in arrays. Alternative to MMIC phase shifters such as thin film ferroelectric phase shifters and frequency agile devices are also under consideration. Micro-electro-mechanical systems (MEMS) based reconfigurable patch antennas are being actively investigated. Systems and technologies for multiple beams, including digital beamforming are also of interest. State-of-the-art antenna metrology facilities are available.

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Digital Communications Technology — Research and development in digital communications technologies: bandwidth-efficient modulation, error correction codes, transceivers, onboard processing and networking hardware. The emphasis is on next generation digital communication subsystems for aeronautical and space network architectures requiring high rate data delivery. Focus on improving bandwidth and power efficiency, increasing information throughput, minimizing digital hardware complexity, reducing size and power consumption, and maximizing flexibility and reliability of digital implementations for aerospace communications systems. Current thrusts in bandwidth- and power-efficient digital modems and codecs; network interface cards, routers, hubs, LANs; low power digital transceivers; integrated wireless communication devices. State-of-the-art computer design and simulation tools, FPGA design, proof-of-concept fabrication, and experimental testbeds are available.

Gene Fujikawa	(216) 433-3495	Gene.Fujikawa@grc.nasa.gov

Satellite Networks and Architectures — Conducts research and development of advanced aerospace communications network architectures, protocols, standards, technologies and network-based applications to enhance the capabilities of NASA Enterprises to accomplish their missions and objectives. Major research endeavors include: 1) simulation and modeling of next generation network architectures, protocols and topologies for aeronautics and space-based platforms and environments, 2) research into Internet-based protocols, standards, and algorithms to mitigate effects of high delay-bandwidth products, dynamic path delays and variable signal delays, 3) development of advanced test beds to benchmark and evaluate Internet-based protocols, standards and technologies for application to NASA missions, 4) active participation in the Internet Engineering Task Force workgroups that are applicable to the development and utilization of Internet-based protocols in aerospace environments, and 5) design and implementation of advanced hybrid network architectures to support NASA applications. Some specific areas of interest are TCP modifications and enhancements to mitigate variable delays and high latency, next generation transport protocol(s), mobile-IP/routing, ad hoc networking, and quality-of-service protocols.

Calvin T. Ramos	(216) 433-9391	cramos@grc.nasa.gov

Solid State Technology — Research and development of advanced microwave materials, devices and circuits and the technologies required to integrate individual circuit components into microwave subsystems. Research is focused on solid-state circuits for transmit and receive modules in the frequency range of 2-110 GHz. Specific technologies under development include planar transmission lines, passive circuit elements, electromagnetic computer modeling, IV-IV and III-V semiconductor materials for active devices, high temperature superconductor microwave circuits, thin film ferroelectric circuits, and multilayer microwave circuit components and packaging techniques. State-of-the-art experimental and fabrication facilities include thin film deposition and characterization equipment, automatic network analyzers, room temperature and cryogenic probe stations, and a clean room.

Alan N. Downey	(216) 433-3508	Alan.N.Downey@grc.nasa.gov

Vacuum Electronics — Research on vacuum electronics to improve the efficiency, operating life, and communications qualities of electron beam devices for use in space communications. Specific technologies of interest are electron emission (including thermionic, field and secondary emission), electron beam formation and control, electromagnetic/electrodynamic computer modeling and design, application of microfabrication to vacuum devices, and microwave power modules. State-of-the-art experimental and computational facilities are available.

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STRUCTURES AND ACOUSTICS

Advanced Composite Mechanics — Research for development of theories, computational algorithms, and requisite computer codes for the mechanics, analysis, and design of propulsion structures made from high temperature composites. Of interest are polymer matrix, metal matrix, ceramic matrix, and carbon-carbon composites. Research focuses mainly on specialty finite elements for micro-mechanics and laminate theory; improved theories for life and durability prediction under hostile environment and long time exposure effects; probabilistic composite mechanics; and integrated computer programs for component-specific analysis and design, progressive fracture, acoustic fatigue, damping and high-velocity impact. Selective experimental research is conducted in support of theoretical developments.

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Aeroacoustics — Analytical and experimental investigations of the aeroacoustics for air breathing propulsion systems for subsonic and supersonic civil transports. Advanced analyses are developed, applied and validated with experimental data. Model scale tests are conducted in anechoic wind tunnels to identify noise sources and explore new noise reduction concepts. Concepts are developed that reduce aircraft engine noise with minimal impact on aerodynamic performance. Current research emphasis is on fan and jet noise reduction.

Dennis L. Huff	(216) 433-3913	Dennis.L.Huff@grc.nasa.gov

Computational Structures Technology — Development, integration, and demonstration of technology to enhance the role of computational modeling in the design and development process for propulsion and power system structural components. Both efficiency and credibility of computational modeling are of concern, so technologies that streamline the design/analysis process as well as improve the fidelity of computational predictions are of interest. Specific areas of interest include computer-integrated simulation, multidisciplinary computational mechanics, design optimization, and artificial intelligence. Simulation includes object-oriented technology, information models, product schema, distributed computing, virtual reality, and human interfaces. Computational mechanics includes fundamental mechanics principles, discrete solution methods, and parallel computing algorithms. Design optimization includes mathematical programming and optimality algorithms, heuristic methodology, and multidisciplinary design. Artificial intelligence includes expert systems and neural network applications.

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Concurrent Engineering Simulation — Research for developing integrated software packages for the computational simulation of multidisciplinary procedures through which propulsion structural systems are developed, conceived, designed, fabricated, verified, certified, installed, and operated (concurrent engineering). Of interest are simulation models and software packages which consist of: (1) workstations with discipline-specific modules, dedicated expert systems, and local databases; (2) a central executive module with a global database with communication links for concurrent interaction with the multidiscipline workstation; (3) unsupervised-learning neural nets; (4) adaptive methods for condensing and incorporating information as the system evolves; (5) zooming methods; (6) graphic displays; and (7) computer-generated tapes for numerically controlled fabrication machines.

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Deformation and Damage Mechanics — Theoretical and experimental studies of deformation and damage mechanics are conducted to develop accurate methods for determining the deformation response and assessing the useful life of structural components operating at elevated temperatures. Typical examples include turbine vanes, blades, and disks; rocket motor combustion chambers, turbines, and nozzle liners; and hot sections of space and terrestrial power systems. Multiaxial, nonproportional, and nonisothermal loading conditions all prevail in such structures. Research focuses on developing (1) constitutive equations, (2) numerical algorithms for analysis and design, and (3) experimental validation of proposed theories and characterization of material response. Materials under investigation include polycrystalline, single crystal, and directionally solidified metals and their alloys; ceramics; and metallic-, intermetallic-, and ceramic-matrix/fiber reinforced composites.

John R. Ellis	(216) 433-3340	John.R.Ellis@grc.nasa.gov

Fatigue Life Prediction — Both analytical and experimental approaches are used to develop accurate techniques for predicting durability of aerospace components (turbine vanes, blades, disks, rocket nozzle liners, etc.) subjected to complex service loadings. These are subjected to severe cyclic loads in high-temperature environments. Temperatures are high enough to introduce creep, relaxation, metallurgical transformations, and oxidation. The behavior of materials and structures subjected to such environmental factors is studied in the laboratory, and techniques are developed to allow reliable life prediction in advance of service. Materials under investigation include monolithic alloys and ceramics; and newly developed metallic, intermetallic, and ceramic matrix/fiber reinforced composites. Fully equipped, computer-controlled test systems allow rationale behavior to be investigated under uniaxial and biaxial stress states. Also, advanced scanning electron microscopes, transmission electron microscopes, and microprobe facilities are available to investigate fatigue mechanisms at the microstructural level.

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Power Transmission Technology — Power train technology is required for rotorcraft drive systems having higher reliability, longer life and ultrasafe operation, higher power-to-weight ratio, lower noise, lower cost, and higher efficiency. Areas under study include health and usage monitoring systems, new gear arrangements and tooth forms, advanced bearing concepts, materials, lubrication, and cooling. New analytical design and optimization tools for stress analysis, vibration, lubrication, and high-speed gears are being developed. Full-scale helicopter transmission test rigs are available for experimental investigations, as are test rigs for fundamental studies of lubrication, endurance, efficiency, noise of spur, helical, bevel, face, and planetary gear sets.

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Probabilistic Structural Mechanics — Research for developing probabilistic structural mechanics, solution/computational algorithms, and requisite computer codes to quantify uncertainties associated with the parameters and variables required for structural analysis and design for both serial and parallel composites. Research focuses mainly on developing probabilistic theories and models for coupled thermal-mechanical-chemical-temporal structural behavior of propulsion structures made from high temperature materials and including metal matrix, ceramic matrix, and carbon-carbon composites and implementation in serial and parallel machines.

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Shantaram S. Pai	(216) 433-3255	Shantaram.S.Pai@grc.nasa.gov

Structural Dynamics — Development of advanced programs for analyzing, predicting, and controlling the stability and dynamic response of aerospace propulsion and power systems. This work includes analytical and experimental studies of the aeroelastic response of bladed disk systems, and both active and passive damping and mistuning methods for controlling the vibration and stability of high-speed turbomachinery. Actively controlled rotors with magnetic suspension are being developed to apply to energy storage flywheel and a more electric gas turbine engine. Innovative computational methods for analyzing multicomponent dynamic systems such as an engine/airframe system are being applied. Ballistic Impact experiments and structural analyses for engine containment and probabilistic analyses and design optimization methods are also being developed.

George L. Stefko	(216) 433-3920	George.L.Stefko@grc.nasa.gov

Structural Integrity — Research to assure integrity and reliability of aerospace propulsion and power systems and structural components. Areas of emphasis include interrogational methods for avoiding catastrophic fracture, fault-tolerant design, defect assessment, and residual life prediction. Comprehensive life prediction models are sought that incorporate complex stress states, nonlinear material characteristics, microstructural inhomogeneities, and environmental factors. Structural integrity is verified by nondestructive characterization of microstructure, flaw population, material morphology, and other relevant factors. Nondestructive evaluation is carried out using analytical ultrasonics, computed tomography, laser acousto-ultrasonics, and other advanced interrogational technologies. Modern computer science practices are exploited to the fullest, and emphasis is on advanced structural ceramics and composites. Integrated computer programs for predicting reliability and life of brittle material components are generated.

John P. Gyekenyesi	(216) 433-3210	John.P.Gyekenyesi@grc.nasa.gov

Tribology and Surface Science — Research to gain a fundamental understanding of the lubrication, adhesion, and wear phenomena of materials in relative motion that meet increased speed, load, and high temperature demands of advanced aerospace propulsion and power systems. Liquid, solid, and vapor phase lubricants are formulated and characterized. Novel, foil air-bearing designs and advanced solid lubricant formulations for use with these high temperature air bearings are investigated. Surface and interface chemistries and morphologies as well as tribological behavior are examined in situ using a variety of techniques, including Auger electron and x-ray photoelectron spectroscopy, infrared and Raman microspectroscopy, secondary electron and atomic force microscopy and profilometry.

Christopher Dellacorte	(216) 433-6056	Christopher.DeLlacorte@grc.nasa.gov

Turbine Engine Seal Technology — Turbine engine seal technology is being developed for next generation aircraft engines having higher power-to-weight ratio, longer life, higher reliability, and higher efficiency. Areas under study include new seal designs, design optimization, high temperature solid film lubrication, performance and durability tests under engine-simulated conditions (up to 1500°F). New analytical design tools are being developed for predicting seal flow rates, for modeling complete turbine secondary air flow systems in which seals play an integral role, and modeling seal stiffness and damping characteristics. A state-of-the-art turbine engine seal test rig is being fabricated to test seals under all temperature, speed and pressure conditions envisioned for next generation commercial and military turbine engines.

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TURBOMACHINERY AND PROPULSION SYSTEMS

Aerospace Propulsion Combustion Technology — Research to better understand the basic physical and chemical processes in selected liquid rocket engine technologies that are synergistic to aeronautic propulsion. Disciplines include high-energy propellant chemistry, ignition, combustion, heat transfer and cooling in thrust chambers, nozzle flow phenomena, performance, and combustion stability. Of particular interest are the fundamentals involved in combustion; cooling; nontoxic and in situ propellant combustion component technologies; micro-combustor technologies including diagnostics and flow analysis; gas-gas injector technology including stability, performance, and compatibility; laser, combustion wave, and catalytic ignition; low cost combustion devices design; and non-intrusive diagnostics including quantitative supercritical spray characterization. Work is conducted through detailed analytical and experimental programs to determine feasibility or applicability and to develop and validate models to describe the processes.

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Aircraft Icing — Analytical and experimental research directed at enhancing safety of flight and developing simulation tools to aid in design efforts associated with flight in icing. Technology elements of interest include: novel concepts for aircraft ice protection/detection; computational and experimental methods for simulation of aircraft icing; fundamental experiments to understand and model the physics of ice formations; computational and experimental methods for quantifying changes in aircraft performance with ice buildup on unprotected components; and novel concepts for remote detection of icing conditions.

Interdisciplinary efforts are devoted to developing instruments to characterize icing cloud properties, measure ice accretion on surfaces, and detect changes in aircraft performance in icing conditions. Experimental research is conducted with a specially equipped Twin Otter aircraft and in the Glenn Icing Research Tunnel, the largest refrigerated icing tunnel in the world.

Thomas H. Bond	(216) 433-3900	Thomas.H.Bond@grc.nasa.gov

Compressor Technology — Research to advance compressor technology for gas turbine engines for a wide range of civil and military applications. Areas addressed include advanced axial and radial compressors as well as innovative components such as wave rotors. Experiments to verify selected fluid mechanics computations, allow development of models, and advance understanding of flow physics. State-of-the-art experimental facilities, instrumentation, and data acquisition, reduction, and analysis methods and facilities are employed.

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Emissions Technology — Experimental and analytical research to advance the understanding of emissions formation in combustion processes in subsonic and supersonic gas turbine aircraft engines. Emittants concerned include oxides of nitrogen, speciation of hydrocarbons and sulfur oxides, and carbon-based gaseous or liquid particulates. Experimental work includes emission characterization in flame tube and sector combustors using advanced diagnostics. Analytical work includes the development of new analytical models for processes such as turbulence-chemistry interaction or the use of advanced computer codes to predict combustion emissions and compare with experimental results. State-of-the-art experimental facilities, instrumentation, analysis methods and computational facilities are employed.

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Engine Systems Technology — Analytical and experimental research in propulsion systems for subsonic, supersonic, hypersonic, and space applications. Advanced concepts currently of interest include rocket and turbine-based combined cycles as well as pulse detonation engines. These are developed through systems studies identifying critical component and component integration issues followed by experiments and additional analyses. Research also includes development and application of new techniques, such as advanced numerical methods, grid generation, and turbulence modeling, for analysis of aerospace propulsion systems. Advanced computational technologies, including parallel processing, interactive graphics, database technology and object-oriented techniques, are applied to propulsion system simulation in order to reduce the time and cost of system design. Optimization and inverse design methods are also of interest.

Richard A. Blech	(216) 433-3657	Richard.A.Blech@grc.nasa.gov

Inlet Fluid Mechanics — Experimental and computational efforts devoted to the fluid mechanics of inlets for aerospace propulsion systems for vehicles ranging from subsonic through supersonic and up to hypersonic. Experiments are intended to demonstrate overall inlet performance, investigate specific inlet flowfield phenomena, provide data sets for the validation of computational methods, and increase the understanding of fundamental inlet fluid physics. Computational research involves application of advanced methods to predict inlet aerodynamic performance, development of improved computational models, and development of new methods to improve computational accuracy and convergence rates. State-of-the-art experimental facilities, instrumentation, analysis methods and computational facilities are employed.

Thomas J. Biesiadny	(216) 433-3967	Thomas.J.Biesiadny@grc.nasa.gov

Low Noise Nozzle Technology — Analytical and experimental research on exhaust nozzle aerodynamics and acoustics for high-speed commercial transport applications. The goal is to achieve takeoff noise levels competitive with the best subsonic engine technology. Nozzle system research is conducted with advanced computational codes, and experimentally in large dedicated facilities where aerodynamic and far field acoustic performance and flow details via advanced flow diagnostics can be determined. Fundamental experiments are also performed in smaller facilities to verify selected fluid mechanics computations and to advance understanding of flow physics of advanced mixing and noise suppression processes.

Rickey J. Shyne	(216) 433-3595	Rickey.J.Shyne@grc.nasa.gov

Propellant Systems Technology — Research to advance the technology of aeropropulsion propellant systems from ground support equipment to flight and into the low gravity environment. Disciplines include fluid dynamics, heat transfer, thermodynamics and high energy propellant chemistry. Of particular interest are the fundamentals applied to storage, supply and transfer of sub critical cryogens during launch and coast orbits and production, handling and ignition of densified propellants. Work involves development and usage of prediction codes to describe the processes and detailed experimental programs to validate the models.

Joseph D. Gaby	(216) 977-7542	Rickey.J.Shyne@grc.nasa.gov

Turbine Research and Technology — Research involving the development, assessment, and application of computational fluid dynamics tools and models for turbine design and analysis, and the acquisition and analysis of experimental measurements of flow and heat transfer in turbines. The computational emphasis involves the development and validation of advanced computer codes and models, modification of codes and models to extend range and accuracy, application of codes and models to practical problems. Measurements involve both simplified and realistic, complex geometries, and are used both for the validation of advanced numerical flow and heat transfer analysis codes and for the development of new physical models.

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GODDARD SPACE FLIGHT CENTER

PROGRAM ADMINISTRATORS	
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MISSION

The mission of Goddard Space Flight Center is to expand knowledge of the Earth and its environment, the solar system, and the universe through observations from space. To assure that our nation maintains leadership in this endeavor, we are committed to excellence in scientific investigation, in the development and operation of space systems, and in the advancement of essential technologies. As NASA's lead center for the Earth Observing System, the central component of the Earth Science Enterprise, Goddard's six major laboratories include a broad range of Earth science activities (atmospheres, hydrology, biology and geophysics) related to understanding the Earth as a total ecosystem, as well as a full spectrum of space sciences (astronomy, astrophysics, planetary studies, and space physics) keyed primarily to observations from Earth-orbiting platforms. Strong engineering, flight dynamics, mission operations, communications, data, and computing facilities support these science objectives, allowing Goddard to carry out all aspects of a space-borne science mission from initial concept to final data archiving.

Located on a 1,100-acre campus in suburban Maryland just outside of Washington, DC, Goddard is home to over 4,000 civil servants and 8,000 on-site contractors. Scientific collaborations and industrial partnerships make Goddard the hub of a national and international arena spanning all aspects of science from space.

Graduate Student Researchers Program opportunities are available in the Space Sciences Directorate, the Earth Sciences Directorate, the Applied Engineering and Technology Directorate, and the Systems, Technology and Advanced Concepts Directorate. Research opportunities at Goddard's two remote facilities — the Goddard Institute for Space Studies in New York City and the Wallops Flight Facility on Wallops Island, VA — are included in these listings. Qualified applicants are strongly encouraged to explore areas of interests with the contacts listed prior to submitting a proposal.

All proposals should be addressed to the program office in Greenbelt, MD.

SPACE SCIENCES DIRECTORATE

The Space Sciences Directorate plays a leading role in conceiving and developing instruments and missions for the scientific exploration of space through its three scientific laboratories:

- Laboratory for Astronomy and Solar Physics
- Laboratory for High Energy Astrophysics
- Laboratory for Extraterrestrial Physics

The Directorate's Space Science Data Operations Office designs, develops, and operates data management and archiving systems and provides public access to archived space science data, and conducts related research.

Laboratory for Astronomy and Solar Physics — The Laboratory for Astronomy and Solar Physics (LASP) conducts a broad program of research in experimental and theoretical astronomy, solar physics, and cosmology. Astrophysical phenomena in the sun, stars, and galaxies, as well as the medium between them, are studied with emphasis on their structure, origin, and evolution. Various groups are actively investigating galactic novae, Active Galactic Nuclei (AGN), starbursts and galactic evolution. Two instruments for the Hubble Space Telescope (HST) have been provided by LASP: the Goddard High Resolution Spectrograph (GHRS), and its replacement, the Space Telescope Imaging Spectrograph (STIS). Data are in hand from the GHRS, and the STIS science team is making use of Guaranteed Telescope Observations (GTO) time to explore fundamental problems in high spatial and spectral resolution spectroscopy.

The Solar and Heliospheric Observatory (SOHO) is currently being operated by the Laboratory, and there is much experimental and theoretical work on the structure and dynamics of the sun being done. A new version of the Solar Extreme Ultraviolet Rocket Telescope and Spectrograph (SERTS) is now in fabrication, featuring an all new telescope and detector, designed and developed in the LASP.

Within the lab is a strong instrument development program based on both rocket and balloon flights devoted to studying the solar corona, a variety of UV sources, and the cosmic IR and microwave backgrounds. In addition, IR imaging and spectroscopic instrumentation is being developed for ground-based observatories, the Stratospheric Observatory for Infrared Astronomy (SOFIA), and the Space Infrared Telescope Facility (SIRTF), and the Far-Infrared and Submillimeter Telescope (FIRST). We are developing the Microwave Anisotrophy Probe (MAP) and the High Energy Solar Spectroscopic Imager (HESSI) for launch in 2001. We are actively pursuing the Next Generation Space Telescope (NGST) mission and the Space Ultraviolet-Visible Observatory (SUVO) concept, in collaboration with astronomers and engineers across the community. NGST, a large, infrared telescope passively cooled to low temperatures, is being studied for launch late in the next decade. There will be many opportunities for technical studies of new instrumentation, new telescope designs, and next generation spacecraft operations. There are several archival research programs in progress based on data from the Infrared Astronomy Satellite (IRAS), Infrared Space Observatory (ISO), Cosmic Background Explorer (COBE), Solar Maximum Mission (SMM), SOHO, International Ultraviolet Explorer (IUE), GHRS, and STIS.

Matthew Greenhouse	(301) 286-0596	matt@stars.gsfc.nasa.gov	Infrared Astronomy
Richard Fisher	(301) 286-8701	Richard.R.Fisher.1@gsfc.nasa.gov	Laboratory Chief
Doug Rabin	(301) 286-5682	rabin@stars.gsfc.nasa.gov	Solar Physics
William Oegerle	(301) 286-3417	oegerle@stars.gsfc.nasa.gov	UV-Optical Astronomy

Laboratory for High Energy Astrophysics — High Energy Astrophysics is the study, by way of X-rays, gamma rays, energetic particles and gravitational waves, of cosmic systems and sites and the physical processes operating therein. Studies of the mechanisms that release energy and accelerate particles, and of the thermal and nonthermal mechanisms that convert the kinetic energy of these particles into observable radiation, are the essential ingredients of high energy astrophysics. High energy observations and theory address some of the most fundamental problems in physics and astrophysics: the search for the character and location of "dark matter", testing general relativity in the strong gravity limit, the origin and evolution of heavy nuclei, and the ultimate fate of the matter. Studies are made of the accretion disks around, and magnetospheres of, massive compact objects such as neutron stars and black holes; abundance distributions of hot astrophysical plasmas such as stellar atmospheres, supernova remnants, galactic cosmic rays and the interstellar medium; intercluster gas; the origin of gamma-ray bursts; the natural acceleration of particles in space; the central engines of Active Galactic Nuclei; and the nature of large-scale extragalactic structures. A broad program of experimental and theoretical research is conducted in all phases of astrophysics associated with high energy particles and the quanta produced in the interactions with their environments. The observables are features such as compositions, time variability, spatial structures, and spectral features of the X-ray, gamma-ray and gravitational-wave emissions and particle populations. Experiments are designed, built, tested, and flown on balloons, rockets, Earth satellites and deep space probes. The resulting data are analyzed and interpreted by Laboratory scientists and their associates in the larger high-energy astrophysics community. These studies of the physics of solar, stellar, galactic, and metagalactic high-energy processes lead to development of theoretical models of the origins and histories of these particles and quanta, and provide understanding of the objects and environments in which they arise.

Elihu A. Boldt	(301) 286-5853	boldt@lheavx.gsfc.nasa.gov	Archival X-ray and Gamma Ray Data Analysis
Jonathan F. Ormes	(301) 286-5705	ormes@lheamail.gsfc.nasa.gov	Cosmic Rays
Thomas L. Cline	(301) 286-8375	cline@apache.gsfc.nasa.gov	Gamma Ray Bursts
Jean Swank	(301) 286-9167	swank@pcasun1.gsfc.nasa.gov	Cosmological X-ray Studies
Frank Jones	(301) 286-8715	jones@lheamail.gsfc.nasa.gov	Theoretical Studies

David Thompson	(301) 286-8168	djt@sage0.gsfc.nasa.gov	High Energy (>20MeV) Gamma Rays
Neil Gehrels	(301) 286-6546	gehrels@lheapop.gsfc.nasa.gov	Low Energy (<20 MeV) Gamma Rays
Nicholas White	(301) 286-8443	nwhite@lheapop.gsfc.nasa.gov	Low Energy (<20 MeV) Gamma Rays
Richard Mushotzky	(301) 286-7579	mushotzky@lheavx.gsfc.nasa.gov	Stellar X-ray Sources
Bonnard Teegarden	(301) 286-5277	bonnard@lheamail.gsfc.nasa.gov	Gravitational Waves

Laboratory for Extraterrestrial Physics — The Laboratory for Extraterrestrial Physics (LEP) performs experimental and theoretical research on the physical properties of and dynamical processes occurring in the interplanetary and interstellar media, magnetospheres and atmospheres of the planets, including Earth.

The Laboratory proposes, develops, fabricates, and integrates experiments on Earth—orbiting, planetary and interplanetary spacecraft, and sounding rockets. A major effort in the LEP is the analysis of data from spacecraft experiments flown on NEAR, ACE, Ulysses, Cassini, IMP-8, Geotail, Wind, Polar, Mars Global Surveyor, IMAGE, Lunar Prospector, and suborbital rocket payloads.

Space physics research focuses on plasmas, magnetic fields, electric fields, and radio waves located in planetary magnetospheres and the interplanetary medium. A program in infrared astronomy includes the study of spectra of the outer planets to deduce atmospheric properties. Studies of planetary atmospheres and the solar spectrum in the infrared are also conducted. An extensive program of research, including spectroscopy and physical chemistry related to astronomical objects, studies of molecules and chemical reactions of astrophysical and aeronomic importance are also conducted in special laboratory facilities. Research related to the chemistry and physics of planetary stratospheres and tropospheres, and solar system matter including meteorites, asteroids, comet, and planets also forms an important component of the LEP research.

A strong theoretical program exists which includes the study of solar wind turbulence, the modeling of the magnetosphere, the nonlinear dynamics of the magnetosphere and the development of the next generation of adaptive grid MHD simulation codes.

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Joseph A. Nuth	(301) 286-9467	u1jan@lepvax.gsfc.nasa.gov	Astrochemistry
L. Drake Deming	(301) 286-6519	ddeming@pop600.gsfc.nasa.gov	Planetary Atmospheres, Infrared Spectroscopy and Molecular Structure
James A. Slavin	(301) 286-5839	jslavin@pop600.gsfc.nasa.gov	Electrodynamics
Thomas E. Moore	(301) 286-5236	tmoore@lepvax.gsfc.nasa.gov	Interplanetary Physics and Space Plasmas

Space Science Data Operations Office — This organization offers exceptional opportunities for computer scientists seeking to apply advanced data systems concepts to NASA's challenging space data problems. Areas of interest include massive on-line data management, web-based user interfaces, computer networks, heterogeneous multisource databases, and data visualization. Research is conducted on advanced data systems for scientific data management using expert systems, database machines, mass storage systems and computer visualization, and on developing interactive scientific data systems integrating data archiving, catalog, retrieval, data and image manipulation, and transmission techniques into distributed systems.

Greg Goucher	(301) 286-2341	goucher@nssdca.gsfc.nasa.gov	Computer Networks and Security
Barry Jacobs	(301) 286-5661	bjacobs@lincoln.gsfc.nasa.gov	Computer Science Research
James Green	(301) 286-7354	green@bolero.gsfc.nasa.gov	Satellite Data Analysis Visualization
Joseph King	(301) 286-7355	king@nssdca.gsfc.nasa.gov	Advanced Data Systems

Space Physics Data Facility — This organization is engaged in a range of science research and information technology development efforts with missions such as IMAGE, Wind, Polar, and Geotail. Science areas of current interest include coordinated studies of magnetospheric structure and dynamics, trapped radiation modeling, low-energy cosmic ray studies and imaging of the Earth's magnetosphere with radio waves. The organization is active in data standards and the definition, implementation and operation of data systems supporting data acquisition and analysis from current and future space physics missions.

Shing Fung	(301) 286-6301	fung@nssdca.gsfc.nasa.gov	Magnetospheric Dynamics & Trapped Radiation
James Green	(301) 286-7354	green@bolero.gsfc.nasa.gov	Magnetospheric Imaging
Mona Kessel	(301) 286-6595	kessel@nssdca.gsfc.nasa.gov	Earth's Bow Shock
Robert McGuire	(301) 286-7794	mcguire@mail630.gsfc.nasa.gov	Cosmic Rays

Astrophysics Data Facility — This organization designs, develops and operates data systems that support the processing, management, archiving and distribution of NASA mission data. The staff manages data for specific missions in collaboration with the GSFC Space Science Laboratories and supports the astrophysics community's access to multimission and multiwavelength data archive stored at GSFC. Opportunities exist to study a variety of astrophysical and applied information systems problems, using archived space- or ground-based data. Current areas of staff interest are the interstellar medium, clusters of galaxies, star formation and advanced database technology.

Cynthia Cheung	(301) 286-2780	ccheung@pop600.gsfc.nasa.gov	Information Systems
Dave Leisawitz	(301) 286-0807	leisawitz@stars.gsfc.nasa.gov	Astrophysics

High Performance Computing and Communications (HPCC)/Earth and Space Sciences (ESS) Project — Goddard is interested in research that will improve the usability and performance of distributed memory supercomputers. Areas of particular interest include parallel computational techniques, management of massive amounts of data, frameworks, architecture independent programming, and virtual environments. This work is in support of ESS Grand Challenge science applications, which include multidisciplinary modeling of Earth and space phenomena, and analysis of data from remote sensing instruments.

Jim Fischer	(301) 286-3465	James.R.Fischer.1@gsfc.nasa.gov	http://sdcd.gsfc.nasa.gov/ESS/

EARTH SCIENCES DIRECTORATES

The overall goals of the Earth Sciences Directorate (ESD) are:

1. To serve as a national resource for discovery in Earth science and related technology development.
2. To be an international Center of Excellence for research in Earth science and technology.
3. To enhance the nation's technological and scientific literacy by sharing the information and knowledge that result from the performance of Earth science research.

In each, scientific efforts involve research, development, and application of advanced space technologies: 1) to develop better knowledge of the distribution and characteristics of Earth's natural resources and how they are changing and 2) to develop a better understanding of processes affecting global change.

The Directorate is at the forefront in theoretical and experimental research dedicated to improving the understanding of the structure, dynamics, radiative, and chemical properties of the Earth's atmosphere, including the troposphere, the stratosphere, and the mesosphere from the global scale to the mesoscale. Research is also performed concerning the physical and biological changes of Earth's surface and interior. Data are acquired and analyzed on plate tectonics, local earthquake hazards and added geodynamics. Theoretical and experimental research in oceanic, cryospheric, and hydrologic sciences is performed. The research includes studies of the hydrological cycle, physical and biological oceanography, and cryospheric phenomena such as ice sheets, sea ice, and snow cover dynamics. Planetary atmospheres, paleoclimate, and geologic structure to improve the understanding and prediction of climate changes on Earth are studied as well.

In all areas applied, research and technology development is an emerging area of study. The Directorate performs computation, modeling, and processing of spaceborne and other observational data, applying the results to improved understanding of the Earth, the solar system, and the universe. Major support is provided to the U.S. Global Change Research Program and to NASA's Earth Science Enterprise by developing and maintaining a comprehensive information system for global change research and education. The Directorate provides data set information, and archives and distributes Earth Science data from many sources, both national and international. It also generates science data sets based on signals from space-based, airborne, and ground-based instruments.

Blanche Meeson	(301) 614 - 5341	bmeeson@see.gsfc.nasa.gov

Global Change Data Analysis Center — The Global Change Data Center (GCDC) provides Earth science data operations and archive management to key Earth science flight missions. The Center ensures that data within the archive are readily accessible through the Goddard Distributed Active Archive Center (GSFC/DAAC) and operates key advanced data systems to support NASA flight missions. The GCDC interacts closely with the scientific community being served.

The Goddard DAAC Facility is responsible for the acquisition, archiving, and dissemination of scientific data from specific Earth science missions. It develops, implements, and operates the GSFC/DAAC data system; interfaces the GSFC/DAAC with the other NASA DAAC systems in order to provide timely access to archived data and information; provides special services for the Earth science communities; performs scientific analysis; and generates multidisciplinary data bases. It also oversees management of the archival systems and facilities of the GCDC; maintains the archive and preserves valuable information content against physical deterioration of the storage media; and produces a regular publication promoting and informing the science user community of its archive contents and services.

The Earth Science Data Operations Facility works closely with flight project personnel in data system planning and utilization, and develops and implements the capability to support Earth sciences mission needs. The Facility is responsible for supporting instrument algorithm development and operational project data set production systems; developing such systems for specific NASA flight projects such as the Earth Probes; and developing nationally accessible advanced data projects for the area of Earth science. It conducts research in advanced computer science methodologies for application to science data operations, and oversees management of the computer systems needed to process project data systems.

Steve Kempler	(301) 614-5765	kempler@daac.gsfc.nasa.gov	Goddard DAAC Facility
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Richard Kiang	(301) 614-5375	rkiang@tsdis.gsfc.nasa.gov	Earth Science Data Operations Facility

Laboratory for Atmospheres — This laboratory performs a comprehensive theoretical and experimental research program dedicated to advancing our knowledge and understanding of the atmospheres of the Earth and other planets. The research program is aimed at advancing our ability to predict the weather and climate of the Earth's atmosphere; advancing our understanding of the structure, dynamics, and radiative and chemical properties of the troposphere, stratosphere, mesosphere, and thermosphere; determining the role of natural and anthropogenic processes on the ozone balance and climate change; and advancing our understanding of the physical properties of the atmospheres of the Earth and other planets. Additional information on our research activities can be found on the Laboratory Web site at http://atmospheres.gsfc.nasa.gov/.

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Data Assimilation Office — Data assimilation combines information from observations with information from prognostic models to produce optimal time series estimates of the Earth. This Office advances the state-of-the-art of data assimilation and the use of data in a wide variety of Earth system problems, develops global data sets that are physically and dynamically consistent, provides operational support for NASA field missions and Space Shuttle science, and provides model-assimilated data sets for the Earth Science enterprise.

Robert Atlas	(301) 614-6140	ratlas@dao.gsfc.nasa.gov

Mesoscale Atmospheric Processes Branch — This branch performs research on a broad range of meteorological problems ranging from convective cloud scale through synoptic scale to the global scale. The research emphasis is on the initiation, evolution, and impact of atmospheric precipitating systems and on the remote measurement of precipitation. Scientists in the branch employ theoretical and numerical modeling methods, observational analyses, and participate in sensor development for the measurement of precipitation, clouds, and water vapor. Specific topics include tropical and mid-latitude convective precipitation systems, fronts and gravity waves, tropical and extratropical cyclones, air-surface interactions, and global precipitation analysis. The branch also conceives and develops advanced remote sensing instrumentation to measure meteorological parameters with emphasis on lidar systems.

David Starr	(301) 614-6191	staff@climate.gsfc.nasa.gov

Climate and Radiation Branch — This branch conducts basic and applied research with the goal of improving the fundamental understanding of regional and global climate on a wide range of spatial and temporal scales. Emphasis is placed on the physical processes involving atmospheric radiation and dynamics, in particular, processes leading to the formation of clouds and precipitation and their effects on the water and energy cycles of the Earth. Currently, the major research thrusts of the Branch are: climate diagnostics, remote sensing applications, hydrologic processes and radiation, aerosol/climate interactions, and modeling seasonal-to-interannual variability of climate.

William Lau	(301) 614-6772	lau@climate.gsfc.nasa.gov

Atmospheric Experiment Branch — This Branch conducts experimental research in terrestrial, cometary and planetary atmospheres concerning chemical composition, atmospheric structure and dynamics. Scientists and engineers in the Branch participate in scientific investigations from experiment conception through flight hardware development, space flight and data analysis and interpretation. Neutral, ion, and gas chromatograph mass spectrometers are developed to measure atmospheric gases from entry probes and orbiting satellites.

Hasso Niemann	(301) 614-6381	niemann@pop900.gsfc.nasa.gov

Atmospheric Chemistry and Dynamics Branch — This Branch conducts research aimed at understanding the radiation-chemistry-dynamics interaction in the troposphere-stratosphere-mesosphere system. Branch scientists develop remote-sensing techniques to measure ozone and other atmospheric trace constituents important for atmospheric chemistry and climate studies, develop models for use in the analysis of observations, incorporate analysis results to improve the predictive capabilities of models, and provide predictions of the impact of trace gas emissions on the ozone layer.

P. K. Bhartia	(301) 614-5736	bhartia@chapman.gsfc.nasa.gov

Laboratory for Terrestrial Physics — The Laboratory for Terrestrial Physics (LTP) advances the scientific knowledge of the Earth and planetary solid-body physics. In the scientific branches, research is pursued on the distribution of mass within the Earth-ocean-atmosphere system, the origin of the Earth's magnetic field, the nature of the movement of the tectonic plates which form the Earth's crust, the effect of variation in the momentum of the atmosphere and changes in the hydrosphere on the Earth's rotation rate, the role of vegetation in the carbon cycle, the most efficient dataset required to detect and interpret change at the ecosystem level, and the nature of the surface topography and crustal interior structure of the Earth, Moon, and planets especially Mars and Venus. The Laboratory has a significant capability to design, develop and test laser and electro-optic remote sensing instruments. The LTP has designed and managed several spacecraft instruments.

David Smith	(301) 614-6010	http://1tpwww.gsfc.nasa.gov

Geodynamics — Research topics include the structure and composition of the Earth's interior through geodetic studies of the gravity and magnetic fields, the study of the lithosphere through magnetic anomalies, the rotational parameters of the Earth and planets, the measurement of Earth and planetary topography with altimeters and the study of planetary landforms and surface processes as related to crustal evolution.

Herbert Frey	(301) 614-6468	http://denali.gsfc.nasa.gov

Terrestrial Information Systems — Advances research programs and institutional administrative activities through research in and applications of information technology. Activities include development of data systems to process and distribute information from Earth observing satellites, aircraft sensors, ground-based networks and field experiments, develop software for visualization, analysis, and presentation of scientific data.

Edward Masuoka	(301) 614-5515	http://ltpwww.gsfc.nasa.gov/ltptis/922hmpg.htm

Biospheric Studies — Biospheric studies include research on terrestrial ecosystem-atmosphere interactions, and ecological patterns and processes occurring at local, regional and continental spatial scales, as well as basic remote sensing research. A wide variety of remote sensing models and passive and active instruments are used to develop a fundamental understanding of the interaction of electromagnetic radiation with terrestrial surfaces. Laboratory, field, aircraft, and satellite investigations are used to characterize the spectral distribution, bi-directional reflectance, and polarization response of terrain features at visible, infrared and microwave frequencies. Techniques are developed to create, process, and analyze multiyear global datasets. Time series of satellite data are used to study the seasonal dynamics of global vegetation, interannual variations in production of semi-arid grasslands, tropical forest alteration, and to provide improved surface characterization for input into global models.

Darrel Williams	(301) 614-6692	http://ltpwww.gsfc.nasa.gov/bsb/Home.html

Laser Instruments — Designs and develops advanced electro-optic and laser sensors for ground-based, airborne and spaceborne Earth and planetary science investigations. Work includes laser and detector research, sensor development research and conceptual design, performance calculations, sensor engineering and fabrication, as well as calibration and integration. Sensors are used for measurements of Earth and planetary surfaces and of the Earth's atmosphere and oceans. The branch also develops advanced laser sensors, including laser altimeters and lidar systems, for airborne and spaceborne use.

James Abshire	(301) 614-6717	http://ltpwww.gsfc.nasa.gov/eib/Home.html

Space Geodesy — Space Geodesy research studies the motion of the Earth on its axis, the kinematics of plate motion and deformation of the crust, the Earth and ocean tides, variations in sea level, core dynamics, and models of the gravity fields of the Earth and planets. Data comes from precise geodetic methods, including laser ranging and very long baseline interferometry, altimetry, data from highly accurate tracking systems such as GPS and doppler, gradiometry and satellite-to-satellite tracking.

Benjamin Chao	(301) 614-6104	http://cddisa.gsfc.nasa.gov/926/926.html

Laboratory for Hydrospheric Processes — The Laboratory performs theoretical and experimental research on various components of hydrology and its role in the complete Earth science system. The program is aimed at observing, understanding, and modeling the global oceans and ice, surface water, and mesoscale atmospheric processes. The Laboratory conducts research on Earth observational systems and techniques associated with remote and in-situ sensing.

William Barnes, Associate Chief	(301) 614-5675	wbarnes@neptune.gsfc.nasa.gov

Oceans and Ice Branch — This Branch conducts oceans and ice research to enhance understanding of these systems and their relationships with other elements of the Earth's climate. Research focuses on problems in biological, physical, and polar oceanography; glaciology; and marginal ice zones, air-sea interactions, and coupled climate modeling. Interdisciplinary studies on problems such as those involving productivity and carbon fluxes, seasonal-to-interannual prediction, upper ocean and thermohaline circulation of the oceans; ice/ocean coupling; and ice sheet dynamics are conducted. The branch is involved in a number of ongoing and planned NASA satellite missions, as well as field campaigns.

Chester Koblinsky	(301) 614-5697	chet@neptune.gsfc.nasa.gov

Observational Science Branch (Wallops Island, VA) — This Branch conducts theoretical and experimental research to validate, calibrate and extend measurements made by Earth Science satellite sensors, as well as explores and develops new technology for improving measurements made not only from satellite but also from aircraft and ground-based instrumentation. It enables science by monitoring satellite altimeters such as TOPEX and quality controlling data they collect. The Branch also conducts fundamental research on Earth Science processes both in the laboratory and in worldwide field campaigns. The Branch does so by maintaining and operating research facilities which include: Air-Sea Interaction Facility (NASIF), Rain-Sea Interaction Facility (NRSIF), Rain Simulation Facility (RSF) and instrumentation systems which include: Airborne Oceanographic Lidar (AOL), Airborne Topographic Mapper (ATM), Scanning Radar Altimeter (SRA), Radar Ocean Wave Spectrometer (ROWS), the Experimental Advanced Airborne Research Lidar (EAARL), the TOGA C-band research weather radar and the new dual polarization weather research S-band (NPOL) Radars, Dobson spectrophotometer, and balloon-borne ozone and meteorological sensors. The Branch is located at the NASA GSFC Wallops Flight Facility at Wallops Island, VA.

John C. Gerlach	(757) 824-1515	http://osb1.wff.nasa.gov/

Hydrological Sciences Branch --- Water sustains life on Earth unifying the land, oceans, and atmosphere into an integrated physical system. The movement of water in its various phases(gaseous, liquid, solid) across the Earth constitutes the global hydrological cycle, and the exchanges of energy associated with these phase changes are a fundamental driving force for our weather and climate systems. Despite its importance, some scientific aspects of the global hydrological cycle and its underlying physics are still poorly understood. That lack of knowledge prevents accurate estimates of global hydrological processes and limits our ability to understand and to predict the response of global hydrology to anthropogenic and/or natural climate change. The Hydrological Sciences Branch (code 974) at Goddard Space Flight Center is the only organization within NASA dedicated exclusively to the understanding, quantification, and analysis of the different components of the global hydrological cycle, with particular emphasis on land surface hydrological processes and their interaction with the atmosphere.

Research activities focus on both 1) interpretation of remotely sensed data and 2) land surface hydrological, meteorological and climatological modeling. The integrating properties of remote sensing techniques provide a potential for complete hydrological measurements over multiple time and space scales. To realize this potential, the Branch is developing, testing, and applying algorithms for translating remotely sensed measurements into soil moisture content, snow mass, precipitation, evapotranspiration, vegetation density and other relevant hydrological quantities at the land/atmosphere interface. In addition, hydrological and atmospheric models are being developed concurrently that utilize remote sensing data for input, calibration, and validation within a wide range of temporal and spatial contexts. All of these studies serve to improve our understanding of how the various components of the hydrological cycle interact, and provide us with important information about the current structure of global hydrology and how mankind is changing the hydrological environment.

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Microwave Sensors Branch — This Branch performs research and development on advanced microwave sensing systems and data collection systems directed at providing remote and *in-situ* data for research in the areas of the oceans, ecology, weather, climate, and hydrology. The Branch performs basic theoretical, laboratory and field studies that elucidate the interaction of electromagnetic radiation with the environment to improve our understanding of remote sensing systems. Branch members contribute to the development of microwave science and engineering for the Tropical Rainfall Measurement Mission (TRMM), the Earth Observing System (EOS), and various airborne campaigns.

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SeaWiFS Project — The Sea-viewing Wide-Field-of-view Sensor (SeaWiFS), was successfully launched on Orbital Sciences Corporation's SeaStar satellite on August 1, 1997, and is providing global observations of ocean color for NASA. These data are being used to assess phytoplankton abundance, ocean productivity, and the ocean's role in the global carbon cycle. In addition, the observations are useful for visualizing ocean dynamics and the relationships between ocean physics and large-scale patterns of productivity. The SeaWiFS Project is responsible for the validation of the data products that include the sensor calibration, atmospheric correction, and bio-optical algorithms.

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SIMBIOS Project — The Sensor Intercomparison and Merger for Biological and Interdisciplinary Oceanic Studies (SIMBIOS) Project will develop a methodology and capability to combine data products from various ocean color satellite instruments, e.g., SeaWiFS, OCTS, POLDER, and MODIS, in a manner that ensures the best possible global coverage. This work requires evaluations of the sensor characteristics and calibrations, and the atmospheric correction and bio-optical algorithms used by each flight project. The project is supported by the SIMBIOS Science Team who collects much of the field data used for product evaluation. The developed merged data set will improve the ability to capture short term changes in the ocean more effectively than any individual ocean color mission. The data will then be used to assess phytoplankton abundance and model ocean primary productivity and associated atmospheric-ocean carbon transfer.

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Earth and Space Data Computing Division — The Earth and Space Data Computing Division (ESDCD) enables NASA-supported scientists to increase their understanding of Earth and its environment, the Solar System, and the Universe through the computational use of space-borne observations and computer modeling. To help assure the research success of NASA- and Goddard Space Flight Center (GSFC)-related projects and programs, we are committed to providing the science community with access to state-of-the-art high performance computing, leading-edge mass storage technologies, advanced information systems, and the computational science expertise of a staff dedicated to supporting that community.

The ESDCD manages and operates the NASA Center for Computational Sciences (NCCS), a primary supercomputing and data storage center for support of NASA missions and programs, and, on a national basis, for approved programs of the external NASA and university communities. The ESDCD utilizes state-of-the-art computational equipment and data systems to provide end-to-end support of computational research conducted by the Earth and Space Sciences Directorates at GSFC and to a somewhat lesser extent external NASA approved research investigators. Specifically, the ESDCD meets its science-driven requirements by providing specialized computational processing and archival services for approved projects and individual scientists as well. In addition, the ESDCD provides support in the areas of sensor algorithms for direct ground communications readout of satellite transmissions, information processing, discipline data base management systems, high performance computing and parallel processing, high speed local and wide area network support, and advanced science data visualizations systems.

The NCCS engages in the application of advanced computer system architectures, such as a suite of CRAY SV1, IBM SP and SGI Origin 2000 computers, and scalable parallel machines such as the SGI/CRAY T3E, to support complex computational physics modeling efforts. These modeling efforts involve, for example, studies of coupled multidimensional ocean and atmospheric systems, multidimensional magnetospheric-ionospheric systems, and astrophysical processes. Specific research opportunities exist for development of new numerical algorithms in computational physics that utilize advanced computer architectures, development of advanced scientific visualization, algorithms for visualization of space and Earth science processes, and the development of advanced techniques for managing decaterabyte mass data storage and delivery systems.

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GODDARD INSTITUTE FOR SPACE STUDIES (NEW YORK, NY)

Goddard Institute for Space Studies (New York, NY) — The Goddard Institute for Space Studies conducts comprehensive theoretical and experimental research programs in four major areas.

Planetary Atmospheres — Concerned with investigations of Jupiter, Saturn, Venus, Mars, and the Earth. The observational phase of the program includes imaging and polarization measurements from the Pioneer Venus Orbiter, radiation-budget, temperature-sounding, photometric, and polarization measurements from the Galileo Jupiter Orbiter, temperature mapping from Mars Climate Orbiter, Cassini imaging of the Jupiter-Saturn system, and Titan wind measurements from the Huygens probe. The theoretical phase of the program includes interpretation of radiation measurements of planets to deduce bulk atmospheric composition and the nature and distribution of clouds and aerosols, and analytical and numerical models of planetary circulations. Emphasis in the theoretical program is on analysis of physical processes in terms of general principles and models applicable to all planets.

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Causes of Long-Term Climate Change — Causes of Long-Term Climate change encompasses basic research on the nature of climate change and climatic processes, including the development of numerical climate models. Primary emphasis is on decadal to centennial global-scale simulations, including studies of humanity's potential impact on the climate. Climate sensitivity and mechanisms of climatic change are investigated in global paleoclimatic research, specifically from the comparison of pollen and glacial data with paleoclimatic model simulations. In addition to their use for climate simulations, the global models are used to simulate the transport of atmospheric constituents and thus study their global geochemical cycles. The program also includes development of techniques to infer global cloud, aerosol and surface properties from satellite-radiance measurements as part of the International Satellite Cloud Climatology Project and the Earth Observing System and analysis of the role of clouds in climate.

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Remote Sensing of Clouds and Aerosols — Remote Sensing of Clouds and Aerosols is concerned with the development and application of techniques to infer cloud and aerosol properties from satellite radiance measurements as part of the International Satellite Cloud Climatology Project (ISCCP), the Global Aerosol Climatology Project (GACP) and the Earth Observing System (EOS). This program includes the validation of the retrieval products through the correlative analysis of *in situ*, ground-based, airborne and satellite data; the development and application of algorithms designed to fully exploit the information content of multispectral radiance and polarization data and the analysis of multisensor satellite data sets. Essential to this program is the analysis of the role of clouds in climate and the evaluation of aerosol direct and indirect radiative forcings. This program also includes theoretical studies of single and multiple scattering of electromagnetic radiation by cloud and aerosol particles.

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Interdisciplinary Research — Interdisciplinary research ranges from theoretical studies of the origin of the solar system to relationships between the Sun, terrestrial climate, geological processes, and biology. One phase of the program involves the structure and evolution of accretion disks, especially the primitive solar nebula, using models of large-scale turbulence. Another area concerns the evolution and pulsation of bright stars, which may be analogs of the Sun. A biological question of special interest concerns how terrestrial vegetation will change during the next 50 years, when climate and atmospheric CO2 are expected to be changing. Related research topics involve impacts of climate variability and change in integrated biophysical and socioeconomical systems.

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Applied Engineering and Technology Directorate (AETD) — The AETD has the full range of discipline engineering capability required to support all phases of NASA's current Earth and Space Science missions and implements a broad range of advanced technology initiatives required to enable and enhance a new generation Space and Earth Science missions.

AETD provides discipline engineering expertise in the areas of information systems; electrical systems; mechanical systems; guidance, navigation and control; and scientific instrument development. AETD designs, develops, and tests components, subsystems, scientific instruments, and spacecraft for NASA programs and projects including the Microwave Anisotropy Probe, the Earth Orbiter 1, the Hubble Space Telescope, and many others. The Directorate also provides the engineering and technical discipline expertise required to development spacecraft (such as, the Geostationary Operational Environmental Satellite series) for external customers like the National Oceanographic and Atmospheric Administration.

AETD conducts innovative technology research and development for scientific space applications in a number of focus areas including:

- Large Aperture Systems (synthetic aperture, segment/adaptive optics, large lightweight deployables, thermal control surfaces, etc.)
- Advanced Instruments (optical components, laser sensing, cryogenic coolers, radiation detectors, microwave sensors, etc.)
- Distributed Observatories (micro/nano satellites, formation flying, platform subsystem component technologies, etc.)
- Rapid Formulation/Execution Environment (collaborative & virtual environments; intelligent Systems; advanced simulation tools; etc.)
- End-to-End Science Information Systems (autonomy, software tools, data processing, communications, reconfigurable computing, etc.)

These technologies are developed for future NASA programs and projects including Next Generation Space Telescope, Nanosat Constellation Trailblazer, Earth Observing System, and many others.

In fulfilling Goddard's mission, AETD also provides engineering and technology development support to other NASA Centers, other government agencies, national laboratories, industry, and academia. The Directorate partners with others to accomplish the Nations space objectives in the most effective manner possible while transferring knowledge and technology to enhance the Nation's scientific and technological literacy as well as its economic well being.

Mechanical Engineering Branch — The Mechanical Engineering Branch performs structural and mechanical design for STS and ELV launched spacecraft, instruments, and mechanical ground support equipment. These designs include spacecraft primary and secondary structures; deployable appendages such as solar arrays and antennas and extendible optical benches; inflatables structures technology; flight mechanisms such as actuators, hinges and release mechanisms; instrument structures including optical benches and flexural mounts; and mechanical ground support equipment such as lift slings, dollies, containers, and g-negation hardware. The Branch provides support for the fabrication, assembly, integration, and testing of both spacecraft and instrument structures including structural design research and design optimization of advanced composite materials. The Branch also provides advanced development for maintaining state-of-the-art concurrent engineering technology.

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Electromechanical Systems Branch —The Electromechanical Systems Branch develops precision structures and mechanisms for use in space-flight instruments and spacecrafts. Structures such as telescope assemblies, mounts for optical components and optical benches are developed. Mechanisms and the associated instrumentation and control system are also developed for applications requiring positioning or scanning optical components or assemblies in an instrument. Precision deployed systems such as segmented mirrors for large aperture telescope assemblies are also developed. The group also conducts applied research and development in micro-electromechanical systems, lightweight and smart structures, vibration and motion control systems, magnetic bearings, sensors, actuators and mechanisms for use in cryogenic environments. The group has state of the art laboratories for the fabrication and testing of precision structures, mechanisms and the associated control and instrumentation equipment.

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Thermal Development Branch — This branch is responsible for the development of new thermal control technology for future NASA spacecraft. Current work efforts focus on such technologies as cryogenic two-phase heat transport devices, two-phase capillary pumped loops and loop heat pipes, variable emittance coatings, and heat pumps. The scope of the work encompasses concept development, analytical modeling, breadboard to prototype testing, and conduction of flight experiments. The 7000 square foot laboratory/office area has numerous test loops and is equipped with modern instrumentation, data collection/processing, and other support equipment.

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Optics Branch — The Optics Branch conducts research and development programs in the optical sciences and engineering to support flight experiment development in the areas of high energy astrophysics, solar and stellar astronomy, atmospheric sciences, and ocean and terrestrial sciences. Specific research and development objectives include optical property characterization of solids and thin films, diffraction grating technology, optical system design and analysis, and advanced optical fabrication and testing. Modern laboratory facilities are equipped for optical property studies in the far infrared to soft x-ray, optical component performance at cryogenic temperatures, optical fabrication, and precision metrology. In addition, extensive computer facilities are available to support optical design and analysis studies.

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Cryogenic Technology Development — The Cryogenics and Fluids Branch actively conducts research and development programs in low temperature physics in support of NASA's Earth and Space Science goals and instruments. General research objectives are the development of low temperature technology that advances the state of the art in magnetic refrigeration, cryocoolers (or mechanical coolers), and sub-Kelvin temperature thermometry. The Branch is also involved in the development of low temperature detectors such as the Ideal Integrating Bolometer. The group has ancillary interest in the areas of superconductivity, superconducting magnets, magnetic shielding, and related technologies. Modern laboratory facilities are equipped for detector and material characterization, including cryogenic workstations with automated data collection, and SQUID systems, dilution and adiabatic demagnetization refrigerators, and facilities for evaporation and sputtering of thin films.

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Detectors Systems Branch --- This branch develops detector technology and instruments for space science and earth science applications. Current work is focused on cryogenic detectors and readouts for use in the submillimiter to x-ray, CdZnTe detectors for hard x-ray and gamma-ray, micro-electro-mechanical systems (MEMS), quantum-well infrared photodetectors (QWIPS), GaN solar blind detectors, and ground based and airborne instruments. Facilities include a Class 10 semiconductor fabrication laboratory, detector/electronics testing labs, clean room packaging lab and cryogenic test labs.

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Lasers/Electra-Optics Laboratory — The Lasers and Electro-Optics Laboratory conducts applied research in Electro-optics including high power semiconductor lasers, diode pumped solid state lasers, photo refractive filters, acoustic-optic tunable filters, Fourier transform interferometers and photon counting detectors for remote sensing instruments. A major thrust is the investigation of the use of laser diodes as the transmitter source for active remote sensing instruments. Both the physics and engineering aspects of these systems are under investigation. Instrumentation is being developed and demonstrated for ground-based and flight observational research from ultraviolet to infrared wavelengths.

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Microwave Instrument Technology Branch — This Branch provides engineering and technology expertise to instrument development teams, study teams and proposal teams for end-to-end conceptualization and development of microwave systems. Emphasis is placed on the development of new capabilities that require innovation and present significant challenges in meeting specifications derived from science requirements. Advanced technologies and concepts are demonstrated which enable new measurements, improved performance, and reduced cost, size, and mass of sensors. This Branch also integrates and tests microwave instrument systems, performs system analysis, and supports experimental field campaigns, airborne and space missions.

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Flight Electronics Branch — The Flight Electronics Branch is responsible for providing the technical expertise in the development of Flight Data Systems and its related components, and in the discipline area of Command and Data Handling systems engineering.

Research areas include flight qualified network hardware, advanced data systems architectures, novel instrument/spacecraft data buses, radiation-hardened microprocessors and free space optical data transfer between spacecraft components.

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Component Technologies and Radiation Effects Branch — The Component Technologies and Radiation Effects Branch provides unique and essential parts, radiation, and advanced technology support to internal and external customers and partners to meet mission reliability, cost, and schedule goals in the areas of flight project support and applied research.

Current research areas include space Radiation environment modeling, effects of space environment on electronics parts, and advanced electronic packaging methods.

The applied research aspects of the branch support efforts in: parts and technology issues, development and extension of device and environment models, emerging radiation hardness assurance issues, novel materials and microelectronics developments, emerging photonics.

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Power Systems Branch — The Power Systems Branch provides technical expertise in the field of electrical power for space applications. Power subsystem engineering is provided to support all phases of scientific instrument, special payload, and spacecraft flight programs from conceptual design, through hardware development and test, to end-of-life operations.

Current research areas include Li-Ion battery development, Li-polymer battery development, and small highly efficient power systems for nano-satellite and multifunctional structural batteries.

Other areas of interest include advance energy storage technologies with longer life, and higher energy density for spaceflight applications, higher efficiency solar cell arrays for spaceflight applications, efficient, low noise, high and low voltage power regulators and converters for scientific instruments, and spacecraft.

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Microelectronics and Signal Processing Branch — The Microelectronics and Signal Processing Branch designs, develops and infuses leading edge micro-electronic devices and components for flight and ground customer applications. This includes front-end electronics interface, analog signal filtering and conditioning, analog cryo temperature control systems, analog multiplexing and A/D conversion, digital signal processing and compression.

Current Research areas include Data compression, Advanced modulation and coding, parallel computing and VLSI devices for flight and ground applications.

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Ground Systems Hardware Branch — The Ground Systems Hardware Branch is responsible for the design, acquisition, integration, and engineering of custom ground hardware components and systems that support the development and operation of flight instruments and spacecraft. This includes the development of accelerated science data processing technologies, prototype electronics, test-beds, integration and test systems, subsystem and component bench test equipment, interface simulators, tracking & relay stations, and network control centers.

Research areas include hybrid CPU-FPGA-DSP based computing systems for flight and ground science data processing applications, including hyper-spectral image processing.

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Electrical Systems Branch — The Branch designs and develops orbital, suborbital and carrier electrical systems and selected flight components such as harnesses, flight fiber optic networks, and special purpose interface hardware. It provides electrical systems leads to Instruments and for Project teams who develop electrical interfaces, performance requirements, functional test procedures, and electrical specifications for in-house space programs or provide oversight and electrical systems expertise to out-of-house space programs. The Branch develops mission critical range instrumentation systems by employing new technology insertion to improve the functions necessary to meet the requirements of the sub-orbital, low earth-orbit, and balloon flight projects. It provides new payload development, timing, command, radar and telemetry tracking, and Science Data Products. The Branch develops project unique electromagnetic compatibility requirements and generates the criteria and test approach needed to insure the electromagnetic compatibility of instrument and spacecraft hardware. It provides Electrical Leads to Science Principle Investigators to support unusual, quick reaction missions or proposal development.

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Microwave Systems Branch — The Microwave Systems Branch is responsible for conception, analysis, design, development and engineering of state-of-the-art RF, microwave, millimeter wave, and higher frequency components and systems for GSFC communications and instrument applications. It also provides communications and microwave instrument discipline support to other GSFC organizational elements and flight projects.

Current research areas include narrow and wide band digital radio, spread spectrum communications, low noise receivers, radiometers, and phased array antennas. The Branch develops and tests state-of-the-art microwave instrument and communications antennas. Efforts are concentrated on analytical design methods, but also include materials properties, test/calibration methods, and manufacturing techniques. The Branch develops spacecraft communication systems using current and advanced technology, analytical studies and experimental investigations are proposed and conducted, and technology developments are conducted in support of these mission responsibilities. The Branch develops flight and ground communications equipment in support of the tracking and data acquisition requirements of GSFC low earth-orbit, suborbital, and balloon flight projects.

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Flight Dynamics Analysis Branch (FDAB) — The FDAB provides spacecraft orbit and attitude related analysis for various flight projects. The branch also maintains an active technology development program to advance methods of attitude/orbit determination and control. The FDAB analysis responsibilities require technical expertise in the following areas: attitude determination and control, spacecraft navigation, mission design and trajectory control. Branch engineers involved in attitude determination and control tasks are responsible for the analysis, development, operational support and 'verification' of the mission's attitude estimation and pointing system, and the on-board sensors related to attitude determination. The navigation, mission design, and trajectory control responsibilities of the branch include the analysis, operational support and verification of the flight project navigation systems (both ground and onboard) and orbital trajectories. Currently, research and analysis items active within the organization include:

- Studies related to analyzing attitude sensor performance and calibrations
- Advanced attitude estimation techniques
- Development of new techniques and algorithms for sensor/instrument calibration
- Studies related to the performance characterization and improvement of attitude control systems
- Advanced orbit determination algorithm development and analysis (such as on-board or ground processing with TDRS, ground trackers and GPS)
- Development of new targeting techniques and algorithms for trajectory optimization and control (such as lunar swingbys and libration orbits, automated maneuver control, and formation flying)
- Analysis for development of algorithms for generation of orbit related planning products (such as automated acquisition data)

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Software Engineering Laboratory (SEL) — The SEL aims to provide a center for Software Engineering excellence, focusing on a range of applied research topics of interest to GSFC, in particular, and NASA as a whole. Of particular interest are techniques and approaches that will enable the development of high-quality software systems for application within NASA missions. In the past, the SEL has studied software engineering process and product improvement approaches within the Information Systems Center. It continues to do this with the objective of understanding and characterizing the environment, assessing, refining and infusing new technologies identified as having the potential to improve the environment process; and to package the results of the assessment for the benefit of organization and NASA. Current and previous areas of expertise include: object-oriented design, Cleanroom, Verification and Validation, formal methods for system design, COTS, and testing techniques.

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Mission Applications Branch (MAB) — The Mission Applications Branch develops software systems and applications that are used by Flight Operations Teams and mission analysts to support NASA Earth and Space science missions. The applications typically include non-realtime functions in the domains of guidance, navigation, and control, mission planning and scheduling, and command management, and are operated within targeted Mission Operations Centers. The branch also provides software support to GSFC's Earth and Space Science Directorates for analysis and data processing applications, developing tools to execute within the scientist's desktop environment.

The MAB provides end-to-end software development support of its products, including project management, requirements analysis, design, implementation, testing, and sustaining engineering. Branch personnel often participate in teams with flight project personnel, principal investigators, contractors, and other AETD engineers to develop integrated hardware and software systems for operations support. Branch products include custom capabilities, integrated GOTS/COTS systems, documentation, training, and consultation. Branch personnel apply well-established processes and procedures, as well as state-of-the-art development technologies, to develop cost-effective solutions, which meet customer needs. The MAB also partners with government, commercial, and academic organizations to develop and explore the applicability of new technologies for its products.

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Real-Time Software Engineering (RTSE) Branch — The Real-Time Software Engineering Branch develops ground data systems for integration and test and on-orbit operations of Earth and space science missions. Branch personnel participate in teams with flight projects, principal investigators, other AETD centers and other organizations to develop integrated hardware and software systems for real-time mission support both at Goddard's Greenbelt, Maryland facility and at the Wallops Flight Facility near Chincoteague, Virginia. The system functionality includes spacecraft, instrument, and ground system monitoring and control, launch and tracking services, and data display and analysis. Branch personnel provide system engineering, system planning, conceptualization, requirements analysis, design, implementation, verification and mission-life sustaining engineering for its products. Branch products include assembled Commercial off-the-shelf (COTS) systems, custom capabilities, components, consulting and brokering on behalf of customers. The branch performs prototyping in collaboration with other NASA and government organizations, universities, and commercial partners to advance the state-of-the-art in implementation of its functions and related technologies. Research opportunities exist in the following areas:

1. Real-time data processing technologies and methods: real-time computer resource allocation and data distribution (POC: Barbara Pfarr, Barbara.B.Pfarr.1@gsfc.nasa.gov, 301-286-2058)
2. Data trending and analysis for constellation or multi-spacecraft missions (POC: Jeffrey Ferrara, Jeffrey.F.Ferrara.1@gsfc.nasa.gov, 301-286-6886)
3. "Lights-out", low cost mission operations architectures and technologies: secure, remote mission operations, remote real-time or near real-time access to mission data. (POC: John Donohue, John.T.Donohue.1@gsfc.nasa.gov, 301-286-6149)
4. Advanced Range Technology Initiative (ARTI) activities. Specific interests are in ultra low-cost vehicle tracking systems, air and sea surveillance and display techniques, launch/flight safety decision support tools, and knowledge-based assistive techniques. (POC: Jay Pittman, Jay.Pittman@gsfc.nasa.gov, 757 824-1506, ARTI website at http://www.wff.nasa.gov/~arti/.

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Computing Environments and Technology Branch — The Branch researches, designs, develops, configures, implements a range of information management and knowledge management solutions for the Information Systems Center and the Applied Engineering and Technology Directorate at GSFC. Rapid advances in information technology offer unprecedented opportunities to improve the way we capture, organize, distribute, and access NASA's knowledge base. As part of our core capabilities, the Branch pursues the expansion of web-based technology (portal, data mining, datamarts, electronic communities, web-crawling agents, etc.) to make relevant information available quickly and easily for people to use productively. Additionally the Branch investigates the use of portal technologies for introduction into organizational applications. The Branch assesses the state of knowledge management in industry and Government today to determine the issues and trends and where knowledge management will be in 3–5 years. The Branch compiles and makes available a discipline/vendor survey of what is currently being developed in knowledge management and introduced into the market place. Based on this, the Branch downsizes the survey results for applicability to the AETD/ISC current strategic direction. The Branch identifies, selects, and pilots activities for inclusion into the AETD/ISC information and knowledge architecture.

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Science Data Systems Branch — The Science Data Systems Branch develops and/or provides consultative services for developing data systems to support Earth and space science missions. Branch personnel team with flight projects and principal investigators in the Earth and Space Sciences Directorates to develop systems for operational data capture, level zero and higher level data processing, and data archival, distribution and information management. The systems process various levels of science and telemetry data starting from the point the data reach the ground until they are delivered to scientific users for analysis. The branch is interested in new technologies which can reduce the costs of developing, operating, and maintaining such systems while also addressing the technical challenges associated with shorter system life cycles, increasing data rates, constellations, on-board processing, event-responsive decision-making, larger storage needs, and distributed archives. The branch also wants to provide additional tools for expediting the scientific discovery process. Technical areas where technological advances are needed include Data Distribution, Science Data Formats, Data Mining, Data Visualization, Data Modeling, Data Processing, Data Capture, Information Services, and Data Storage/Archival.

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Advanced Data Management And Analysis Branch — The Advanced Data Management and Analysis Branch supports the Earth and Space Science Communities by providing a wide range of high-end data systems solutions in response to technical requirements. Branch personnel partner with projects and principal investigators in the Earth and Space Science Directorates to develop systems that addresses data display, data analysis, data visualization, data archiving and storage. The Branch also provides support for algorithm development, science data analysis programming, data mining, data retrieval, fusion and dissemination, scientific mission proposal development and support for large and small scale software system configuration, sizing, and development methodologies utilizing recognized techniques and scientific data format standards.

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Advanced Architectures and Automation Branch — This Branch develops and applies systems, hardware, and software technologies to support complex command and control, communications, and telemetry data processing requirements for future space missions. A major focus of its work is in the development of autonomous ground/space systems. The Branch also supports work in the area of advanced intelligent information management. The Branch performs advanced technology development in such areas as: high- performance VLSI systems for telemetry processing, high data rate/volume data storage architectures, distributed systems and networks, computer-aided software and systems engineering, human-machine interface and interaction technologies, artificial intelligence (especially in the areas of expert systems, agents and agent communities, multimodal reasoning (rule-based, case-based, model-based), neural networks, genetic algorithms, etc.), planning and scheduling (both centralized and distributed), monitoring and control, intelligent trend analysis, data and information visualization, virtual environments, and intelligent information management. The Branch also engages in usability testing and cognitive studies associated with human/system interfaces and interactions. Branch laboratory facilities provide some of the most advanced systems design and development capabilities available, including a complete suite of VLSI design tools, libraries, and workstations; workstations including SUN, HP, and Silicon Graphics; advanced tools for system and software engineering, modeling and human/computer interface design; and expert system shells and development environments.

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Systems, Technology and Advanced Concepts Directorate (STAAC) - The Systems, Technology and Advanced Concepts Directorate provides end-to-end systems engineering expertise and leadership for the development of space flight mission systems, advanced concepts, and technology. STAAC is responsible for providing Agency-wide management of areas of technology development for Earth-orbiting space missions and for Small Business Innovation Research, and Technology Transfer programs; leading the transfer and commercialization of technologies at GSFC; developing implementation and risk mitigation strategies for the infusion of technologies into programs, missions and projects; and ensuring that technology advancements are carried from concept through final design.

John A. Hrastar	(301) 286-1047	jhrastar@pop100.gsfc.nasa.gov
Michael Ryschkewitsch	(301) 286-7500	mryschke@pop700.gsfc.nasa.gov

Project Formulation Group - The Project Formulation Group manages the development of feasible mission concepts, formulation of new projects as directed by NASA's Enterprises, and the Access to Space efforts for GSFC and its customers and partners. Key aspects include mission-enabling activities such as requirements development, concept studies, risk mitigation strategies, infusion of new technologies, project definition, and partnership formulation. This process frequently involves identification of technology needs for future missions, which helps guide NASA and Goddard's technology development activities. The development of these new technologies enable future missions, allows achievement of higher performance, and reduced lifecycle mission cost. Missions currently are in formulation for Space Science, Earth Science, and Human Exploration. Associated technology development includes nano-satellite subsystems, autonomous satellite and ground operations, instrument optics and detectors, inflatable technologies, and advanced data systems.

Michael Ryschkewitsch	(301) 286-7500	mryschke@pop700.gsfc.nasa.gov

New Opportunities Office - The New Opportunities Office coordinates GSFC´s new mission initiatives and business opportunities process, provides strategic and prompt response in the pursuit of new opportunities, provides external and internal customer interface for access to GSFC new business services, supports the development of new missions and instruments through the operation of the Integrated Mission Design Center, Instrument Synthesis and Analysis Lab, and Access to Space and develops, produces, and publishes GSFC proposals.

The Integrated Mission Design Center (IMDC) provides the tools and facilities for a highly interactive concurrent engineering environment. By focusing a resident team of expert engineers and a variety of computer-based simulation models, the IMDC is able to analyze a variety of mission concepts and technology alternatives in a fraction of the time needed to complete a traditional mission study effort. The typical IMDC study involves analysis of spacecraft propulsion, electrical power, mechanical, communications and attitude control systems, as well as orbital dynamics and top-level cost estimating. The IMDC will be in a continuous state of evolution as new analytical tools and technologies are introduced, and existing ones are refined.

The Instrument Systems Analysis Laboratory (ISAL) focuses on individual scientific instruments. This laboratory was created to provide end-to-end capabilities for modeling, analysis and simulation for Earth and space science remote sensing instruments. Design and analysis tools are integrated to facilitate quick and efficient Structural-Thermal-Optical, jitter, and detailed radiometric, spectrometric, hyperspectral, and interferometric analyses. Performance modeling (physics based functional modeling) and integrated physical or geometric modeling (structural, optical, thermal, etc.) will be accomplished for both performance analyses and for time-domain simulations. This capability allows efficient trade off of instrument concepts and architectures, including cost and performance validation.

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The NASA Technology Integration Division (NTID) – The NTID has two primary roles. The first role is to manage and integrate Agency-level technology programs for NASA Headquarters and the second role is to commercialize and transfer GSFC technology to industry.

In the role of managing technology programs NTID enables technologies to revolutionize NASA's future. NTID identifies advanced concepts and innovative systems architectures. It seeks to foster breakthrough technologies, and provides leadership in integrated technology planning, development, and infusion. NTID leads the technology transfer and commercialization of NASA Goddard sponsored technology by establishing partnerships with industry, academia and other government organizations to enhance the economic competitiveness and scientific and technology capabilities of the United States.

Alda Simpson	301-286-7214	asimpson@pop700.gsfc.nasa.gov

SYSTEMS ENGINEERING AND ADVANCED CONCEPTS DIVISION

Systems Engineering Support and Advanced Concepts (SESAC) Branch– The SESAC Branch is devoted to delivering services and products to the systems engineering community and its customers. The branch leads the development of advanced mission concepts and provides core capability of end-to-end systems engineering for programs, missions, and projects including innovative concepts, system architectures and systems for new missions, technologies and concepts. The branch establishes and delivers a core set of systems engineering services to our customers, through assembling a cadre of experts in the various systems engineering disciplines and functions. These services include risk management and assessment, requirements development and analysis, operations concept development, formal and informal reviews support, integrated systems analysis, modeling and simulation, verification and validation planning, cost modeling and analysis, technology planning, as well as others. SESAC develops implementation and risk mitigation strategies for the infusion of technologies, ensuring that systems technology advancements are carried from concept through final design. The branch also provides direct support to science and engineering teams in the development of advanced concepts (pre-formulation activities).

SESAC is also responsible for the development and deployment of advanced engineering tools, environments and capabilities, and for the evolution and development of existing capabilities and facilities, including the Integrated Mission Design Center (IMDC), Instrument Synthesis and Analysis Laboratory (ISAL), and the new ISE/NGST Collaboratory. The branch embraces rapidly emerging technologies to create, enhance, and integrate advanced engineering tools and virtual collaborative environments and infuse them into practice. SESAC provides a liaison function and performs tasks in the areas of standards and processes, interfacing with various Agency, national and international organizations. SESAC also implements rigorous mentoring and training systems and opportunities in order to sustain critical core competencies in systems engineering.

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Flight Instrument Division - The Flight Instrument Division provides end-to-end technical management and systems engineering for advanced space and Earth science flight instrument developments. The Division provides technical leadership for the full life cycle instrument development, which includes development of innovative new measurement concepts and techniques, development of advanced instrument concepts, generation of scientific instrument proposals, instrument system definition, analysis, and implementation. In this role, it is responsible for developing programmatic risk mitigation strategies for the infusion of leading-edge technologies into flight instruments and ensuring that technology advancements are carried from concept through final development. Current technology developments include x-ray, visible, infrared, submillimeter, and microwave components and subsystems that are necessary to enable the scientific measurements.

SUBORBITAL AND SPECIAL ORBITAL PROJECTS DIRECTORATE (WALLOPS FLIGHT FACILITY)

Suborbital and Special Orbital Projects Directorate - Wallops Flight Facility — The Suborbital and Special Orbital Projects Directorate (SSOPD) mission is to provide support to the scientific and technology communities through frequent, low-cost flight project opportunities. These flight projects include research carriers and mission operations. The major activities conducted by the directorate are:

Sounding Rockets Program — This program provides "cradle to grave" support to an investigator by designing and analyzing a mission to meet the science requirements; designing, fabricating, and testing the spacecraft; integrating the spacecraft with a suborbital rocket system; and providing project management and launch operations support from numerous worldwide launch locations. Research opportunities include development of new or improved flight vehicle or spacecraft systems that improve science return, increase reliability and safety, and lower mission cost.

Bobby Flowers	(757) 824-2202	bflowers@pop800.gsfc.nasa.gov

Balloon Program — This program provides the science community with access to the upper atmosphere for extended durations from numerous worldwide locations. The SSOPD manages the overall program and performs research and development activities. A major research focus of the program currently underway is the development of balloon systems capable of remaining aloft and supporting science requirements for approximately 100 days. Research opportunities include materials studies, balloon station-keeping and steering, advanced power and data subsystem development, and innovative concept development for new uses of balloons.

Steve Smith	(757) 824-1453	ismith@pop800.gsfc.nasa.gov

Aircraft Projects — This activity utilizes aircraft as a platform to carry scientific equipment, principally in support of Earth Science related programs. The SSOPD provides the project and engineering management necessary to conduct scientific measurements including the integration of experiments on aircraft and modifications of aircraft structures. Research opportunities include development of systems that provide aircraft and environmental information to airborne science experiments.

Doug Young	(757) 824-1443	dcyoung@pop800.gsfc.nasa.gov

University Class Projects — This organization is responsible for mission management of small spacecraft selected and funded by NASA. This management includes providing technical expertise and in-house capabilities to the Principal Investigator. Spacecraft may fly on the Space Shuttle, expendable launch vehicles, or long duration balloons. Research topics include developing strategies for increasing flight opportunities for this class of missions.

David Pierce	(757) 824-1749	dlpierce@pop800.gsfc.nasa.gov

Spartan Projects — Spartan provides frequent, low-cost orbital flight opportunities for flying science and technology experiments. The Spartan carrier is a reusable spacecraft bus that is flown aboard the Space Shuttle, deployed on orbit, and later is retrieved by the Shuttle. This organization is responsible for overall management of missions, including proposal generation, design, development, test, launch, flight operations, and data analysis. These projects are managed at the Greenbelt facility. Research areas include the development of increased carrier capabilities, and new mission concepts for use of Spartan systems.

Don Carson	(301) 286-4968	dcarson@mscmail.gsfc.nasa.gov

Shuttle Small Payloads Projects — This organization manages the design, development, test, integration, and flight operations of small payload carrier systems that fly aboard the Space Shuttle. The carriers include Hitchhiker, Getaway Specials, and Space Experiment Module. These carriers contain science, technology, and education payloads for NASA, other government agencies, educational organizations, commercial entities, or international organizations. These activities are managed at both the Greenbelt and Wallops facilities. Research topics include the development of increased carrier capabilities and new mission concepts for these carriers, including International Space Station activities.

Gerry Daelemans	(301) 286-4271	gdaelema@pop700.gsfc.nasa.gov

International Space Station Research Program — This organization serves as a facilitator to the science and technology community who may be interested in conducting research aboard the International Space Station. In this capacity, the office defines opportunities available for researchers, and assists them with technical issues.

Betsy Park	(301) 286-7062	bpark@pop400.gsfc.nasa.gov

Wallops Test Range — In support of NASA science and technology programs, the SSOPD maintains and operates a Test Range consisting of an integrated launch range and research airport. Test Range resources also include transportable systems capable of conducting launch operations in remote locations. Projects include suborbital and orbital rocket launches, balloon flights, and piloted and unpiloted aerial vehicles. Wallops provides project management, telemetry and radar tracking, communications, range safety, ordnance handling, data reduction, supporting infrastructure, and other support services necessary to a range user. Research topics include development of advanced technologies related to lower cost operations, increased capabilities, and improved safety.

Mike Fillis	(757) 824-1955	mfillis@pop800.gsfc.nasa.gov

Project and Range Safety — The Suborbital and Special Orbital Projects Directorate (SSOPD) Safety office provides safety review and approval for Wallops flight projects including suborbital rocket, balloon, aircraft, and Shuttle payloads. It performs these same functions for operations conducted by the Wallops Test Range, including field campaigns. Additionally, the office provides operational support for these same Test Range missions including ground hazard monitoring, wind measurement and compensation, ship and aircraft surveillance, and flight termination, when necessary. Research areas include new analytical or computational safety techniques in the review of flight projects, safety system reliability determination, and advanced concepts that increase the safety of operations and/or minimize the impacts of safety requirements on flight projects.

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JET PROPULSION LABORATORY

PROGRAM ADMINISTRATORS	
Ms. Linda Rodgers Educational Affairs Office Mail Stop 180-109 Jet Propulsion Laboratory 4800 Oak Grove Drive Pasadena, CA 91109-8099 Phone: (818) 354-8274 FAX: (818) 393-4977 linda.rodgers@jpl.nasa.gov	**Mr. William Whitney** Acting Mgr., Educational Affairs Office Mail Stop 180-109 NASA Jet Propulsion Laboratory 4800 Oak Grove Drive Pasadena, CA 91109-8099 Phone: (818) 354-8251 FAX: (818) 393-4977 william.m.whitney@jpl.nasa.gov

MISSION

The primary role of the Jet Propulsion Laboratory (JPL) within NASA is the exploration of the solar system, including planet Earth, by means of unmanned, autonomous spacecraft and instruments.

JPL scientists, technologists and engineers engaged in Earth atmosphere and geosciences, oceanography, planetary studies (including asteroid and comet), and solar, interplanetary, interstellar, and astrophysical disciplines. Opportunities for Graduate Student Researchers exist in all technical divisions of JPL. These technical divisions encompass almost all JPL engineering and science resources. Each technical division is concerned with the planning, design, development engineering, and implementation functions relevant to its discipline area. Fundamental to the structure of JPL is the cooperation among the functions of research, science, advanced technology, and engineering of these operating divisions.

SYSTEMS

In Systems we provide leadership and expertise for JPL's flight projects and other institutional activities in the areas of systems architecture, systems engineering, and systems management. We formulate, implement, and operate systems comprising hardware, software, and operations.

Donna M. Wolff	(818) 354-1339	donna.m.wolff@jpl.nasa.gov

Mission and Systems Architecture — Includes flight mission architecture development, advanced flight mission and system planning, flight project launch approval planning, design of end-to-end information systems, and flight project and information system engineering. Also performs economics, operations research, costing, and mission analyses for a broad spectrum of unmanned and manned space projects and military and civilian ground-based programs. Performs system level design, integration, and development of information systems, including computer hardware and software and large distributed near real time ground data processing.

Anthony Freeman	(818) 354-1887	anthony.freeman@jpl.nasa.gov

Navigation and Mission Design— Includes interplanetary spacecraft trajectory design, launch vehicle trajectory analysis, and software development to support scientific spacecraft trajectory design. Develops the capability to determine very precisely the position and velocity of scientific spacecraft in interplanetary space through radiomemtric and optical techniques. Plans mission timelines to accommodate science requirements. Designs propulsive maneuvers to place spacecraft on correct trajectories, develops software to solve the equations of motion, and conducts scientific studies of relativistic gravity, planetary, comet, and asteroid orbital dynamics, gravitational radiation and planetary masses and gravity fields using spacecraft radio tracking data.

Michael Watkins	(818) 354-7514	michael.m.watkins@jpl.nasa.gov

Flight Systems Engineering — Supports JPL flight projects by providing design integration of the total spacecraft system, including its interfaces with the launch vehicle and with its scientific instrument payload. Provides design integration of major instrument systems. Conducts studies and analyses of advanced future spacecraft designs, and analyzes the performance of spacecraft in flight. Also performs planning, management and performance of test, integration and launch activities for major systems, including spacecraft, science instruments, ground data systems and ground support equipment. Conducts research and development for integration and test technologies, and operates and manages JPL's major Spacecraft Assembly Facility.

Doug Bernard	(818) 354-2597	douglas.e.bernard@jpl.nasa.gov

Mission Systems Engineering — Supports JPL flight projects in the development of plans for the operation of interplanetary spacecraft in flight, in the design of ground data systems for flight operations, and in managing the configuration of large data systems. Develops the software models and detailed sequences to be executed by interplanetary spacecraft, plans the commands required to carry out the sequences, and develops the software that keeps track of the command sequences and that ensures the commands will safely perform the desired functions. Provides support to science activity development and implementation. Conducts research related to planning and sequencing software technology.

Kathryn Weld	(818) 354-2143	kathryn.r.weld@jpl.nasa.gov

EARTH AND SPACE SCIENCES

The Division conducts a wide-ranging program of research in oceanography, the atmospheres and solid bodies of Earth and other planets, planetary satellites, asteroids, comets, astrobiology, interplanetary medium, solar physics, and astrophysics. Ground-based observations, laboratory measurements, aircraft, balloons, and Earth-orbiting and planetary spacecraft are utilized. Extensive laboratory and theoretical research efforts, data analysis, interpretation, and modeling support these observational programs.

Cliff Heindl	(818) 354-4603	clifford.j.heindl@jpl.nasa.gov

Astrobiology — The Astrobiology program at JPL is a program strongly based in environmental microbiology and microbial ecology, with a focus on the mechanisms whereby life survives in extreme conditions. The environments of study will be alkaline lakes, cold lakes, dry cold environments, and deep subglacial lakes. The studies include field work in these environments, identification of the organisms present, their metabolism, and the potential relationship of these environments and their organisms to extraterrestrial environments that might harbor (or have harbored) life. The ultimate goal is to develop a suite of biosignatures that will allow us to unambiguously identify life in samples on and off Earth, even when the signals of life are very subtle.

Cliff Heindl	(818) 354-4603	clifford.j.heindl@jpl.nasa.gov

Oceanography — Altimetry for determining currents and tides; air-sea interactions including, fluxes of mass, momentum, energy, and chemicals between ocean and atmosphere; determination of marine biomass and ocean productivity; sea ice dynamics and influence on climate variability; global surface temperature measurements; surface driving forces and wave propagation derived from radar observations.

Lee-Leung Fu	(818) 354-8167	lee-leung.fu@jpl.nasa.gov

Earth Atmosphere — Laboratory research, field measurements, and data analysis to understand the chemistry of stratospheric ozone; monitoring of long-term trends in important minor and trace constituents; extraction of meteorological parameters from satellite data, including temperature profiles, humidity, clouds, winds, and pressure.

James Margitan	(818) 354-2170	james.j.margitan@jpl.nasa.gov

Planetary Atmospheres — Observations from ground-based telescopes and analysis of spacecraft data to determine composition, structure, and dynamics; long-term study of seasonal and inter-annual variability; global mapping; synthesis of information to determine physical processes and state of the atmospheres.

Jay Goguen	(818) 354-8748	jay.d.goguen@jpl.nasa.gov

Earth Geoscience — Characterization of exposed rocks, sediments, and soils on the Earth's surface to understand the evolution of the continents; examination of the state and dynamics of biological land cover for assessment of the role of biota in global processes; tectonic plate motion; volcanology; paleoclimatology.

Ronald Blom	(818) 354-4681	ronald.g.blom@jpl.nasa.gov

Planetology — Observations of the surface of the inner planets, the satellites and rings of the outer planets, asteroids and comets across the spectral range from ultraviolet through active and passive microwaves; studies of meteorites and cosmic dust; theory and modeling relevant to the origin and evolution of the solid bodies of the solar system; development of approaches to the detection and characterization of solar systems around other stars.

Bruce Banerdt	(818) 354-5413	william.b.banerdt@jpl.nasa.gov

Space Physics — Mapping of the magnetic fields of the Sun and planets and their time variations; structure and dynamics of the solar wind; interactions of solar fields and particles with the magnetic fields and outer atmospheres of Earth and planets. Development of space plasma instruments.

Bruce Goldstein	(818) 354-7366	bruce.e.goldstein@jpl.nasa.gov

Astrophysics — Galactic and extragalactic astronomy and the development of instrumentation in the infrared, visible, and gamma-ray regions of the spectrum, measurement of the cosmic microwave background, composition and chemistry of interstellar clouds, origins of planetary systems, gravitational wave physics and the detection of gravitational waves.

Harold Yorke	(818) 354- 0336	

TELECOMMUNICATIONS SCIENCE AND ENGINEERING

Astrophysics — Observational and theoretical research into the nature of radio emissions from quasars, galaxies, and stars.

Robert Preston	(818) 354-6895	robert.a.preston@jpl.nasa.gov

Planetary Atmospheres and Interplanetary Media — Experimental and theoretical research investigations based on the use of spacecraft radio signals to probe planetary atmospheres and the interplanetary/solar plasma.

Richard Woo	(818) 354-3945	richard.woo@jpl.nasa.gov

Planetary Dynamics — Determination of orbital, rotational, or atmospheric motions of planets by tracking of spacecraft or balloons associated with the planets.

Robert Preston	(818) 354-6895	robert.a.preston@jpl.nasa.gov

Lunar Dynamics — Use lunar laser ranges to measure lunar rotation and orbit for the study of lunar science and relativity theory.

James Williams	(818) 354-6466	james.j.williams@jpl.nasa.gov

Geodynamics — Experimental and theoretical investigations of global and regional phenomena using the modern space geodetic techniques of lunar laser ranging, Very Long Baseline Interferometry (VLBI) and the Global Positioning System (GPS).

Jean Dickey	(8l8) 354-3235	jean.o.dickey@jpl.nasa.gov

Information Theory and Coding — Theoretical research in information theory, channel and source coding with special emphasis on deep space communications. Design of codes, decoding architectures, and data compression systems, including on-board science processing. Combined coding and modulation for bandlimited channels. Quantum information theory and communications. Evaluation of end-to-end performance of the communication system.

Jon Hamkins	(818) 354-4764	jon.hamkins@jpl.nasa.gov
Fabrizio Pollara	(818) 354-4287	fabrizio.pollara@jpl.nasa.gov

Optical Communication — Theoretical and experimental research involving free space laser communications systems, components, and techniques, and including such item lasers, detectors, modulators, signal design, large telescope design, spatial and temporal acquisition and tracking, detection strategies, and channel coding.

Hamid Hemmati	(818) 354-4960	hamid.hemmati@jpl.nasa.gov

Frequency Standards Research — Experimental investigations in the area of quantum electronics and quantum optics, including ion and atom trapping and tooling, for the development of ultra-stable sources of microwave and optical reference frequencies.

Lute Maleki	(818) 354-3688	lute.maleki@jpl.nasa.gov

Planetary Radar Astronomy — Experimental and theoretical research in planetary surfaces, atmospheres, and rings (including geology, spin dynamics, and scattering properties of rings and cometary debris swarms) using the ground-based Goldstone radar system, the Very Large Array, and Arecibo Observatory to form images of terrestrial planets, asteroids, and comets.

Martin Slade	(818) 354-2765	martin.a.slade@jpl.nasa.gov

Radar Remote Sensing of the Earth — Experimental and theoretical investigations in remote observation of the Earth's surface through radar scattering properties, for example, polarization and interferometry to determine the structure and motion of regions of interest.

Yunjin Kim	(818) 354-9500	yunjin.kim@jpl.nasa.gov

Microwave Antenna Holography — Experimental and theoretical research in microwave antenna holography and related topics. These include: phase retrieval, prescription retrieval, antenna design and optimization techniques, and advanced development of antenna measurement and instrumentation.

David Rochblatt	(818) 354-3516	david.j.rochblatt@jpl.nasa.gov

Atmospheric Remote Sensing — Experimental and theoretical investigations of water vapor in the Earth's atmosphere. Emphasis on providing active calibration of the delay imposed on radio and optical remote sensing techniques.

George M. Resch	(818) 354-2789	george.m.resch@jpl.nasa.gov

AVIONIC SYSTEMS AND TECHNOLOGY DIVISION

Advanced Spacecraft Control Systems — System architectures, sensors, actuators, and algorithms for autonomous rendezvous, docking, aerobraking, and landing. Development of concepts to enable high bandwidth control of flexible space structures and to provide active space control. Development of concepts to enable space interferometry missions.

Tooraj Kia	(818) 354-5165	tooraj.kia@jpl.nasa.gov

Multimission Spacecraft Avionics Core — Develop and design an avionics core for instruments and interplanetary spacecraft. Establish requirements and minimum core architecture that is scalable. Architecture must allow reuse of software, documentation and development tools across multiple missions.

Tooraj Kia	(818) 354-5165	tooraj.kia@jpl.nasa.gov

Spacecraft Autonomy — Architecture for robust and testable highly autonomous spacecraft. Includes supervisory or goal-directed ground-based control. On-board task planning and scheduling. Robust, fault-tolerant on-board sequence or plan execution. Autonomous position determination, autonomous guidance laws. Autonomous attitude maneuvers and propulsive maneuvers, autonomous target acquisition and tracking, autonomous spacecraft resource management, autonomous fault detection, isolation, and recovery. Operations approaches for highly autonomous systems. Testing approaches for highly autonomous systems.

Douglas Bernard	(818) 354-2597	douglas.e.bernard@jpl.nasa.gov

Autonomous Control Systems — Development of advanced control methods and concepts for autonomous spacecraft stabilization, pointing and tracking. Integration of miniature/feature trackers, gyros and advanced metrology systems. Inflight identification, estimation and control strategies for space interferometers. Development of a new generation of control design, modeling, and simulation tools.

David Bayard	(818) 354-8208	david.s.bayard@jpl.nasa.gov

Precision Landing — Research in advanced autonomous control concepts, architectures, design methodologies and algorithms for high precision landing on large and small planetary bodies. Image-based pointing and control.

Fred Y. Hadaegh	(818) 354-8777	fred.y.hadaegh@jpl.nasa.gov

Formation Flying Control — Research in advanced control architectures, algorithms, simulations and testbeds for autonomous high precision control of formation flying of spacecraft. Design of optimal maneuvers for targeting and formation reconfigurations. Advanced algorithms and design concepts for autonomous multiple bodies rendezvous and docking with emphasis on image based pointing and tracking.

Fred Y. Hadaegh	(818) 354-8777	fred.y.hadaegh@jpl.nasa.gov

GPS Receivers – Extend capabilities of BlackJack GPS receivers. Anticipated areas are atmospheric sounding, bistatic radar, and autonomous spacecraft operations enabled by onboard GPS.

Larry Young	(818) 354-5018	lawrence.e.young@ jpl.nasa.gov

Control of Inflatable Antennas — Research in modeling, pointing control, vibration control, and shape control of large, inflatable systems. Analysis and control of optical/RF performance and structural dynamics.

Sam Sirlin	(818) 354-8484	samuel.w.sirlin@jpl.nasa.gov

Interferometric Metrology Systems — Development and testing of space-qualifiable systems and system components for interferometric metrology applications. Frequency stabilized laser sources, integrated optics components, fiberoptic components.

Serge Dubovitsky	(818) 354-9796	serge.dubovitsky@jpl.nasa.gov

Autonomous Vehicles — Real-time path planning in uncertain terrains; locomotion and mobility, computer vision for rover control, and combined mobility and manipulation.

Brian Wilcox	(818) 354-4625	brian.h.wilcox@jpl.nasa.gov

Rover Technology — Rover navigation in uncertain terrains, rover localization, sample acquisition from small rovers, intelligent rover based science experiments, and web-based operator interfaces.

Dr. Samad Hayati	(818) 354-8273	samad.a.hayati@jpl.nasa.gov

Robot Arm Control — Research in advanced manipulator control, adaptive arm control, control of redundant arms, cooperative multiarm control, force and impedance control, motion planning and control of robotic vehicles, robot control architectures, task-level control, sensor-based motion planning and control, intelligent control of robots.

Homayoun Seraji	(818) 354-4839	homayoun.seraji@jpl.nasa.gov

Robotics Man-Machine Systems — Development of controls, sensing, manual and graphics-based user interfaces for telerobotic operations and telepresence. Applications to robotic space servicing and exploration and medical robotics.

Homayoun Seraji	(818) 354-4839	homayoun.seraji@jpl.nasa.gov

Optical/Digital Pattern Recognition — Research and technology development in algorithm, architecture, hardware implementation of pattern recognition systems using both optical and digital implementations. Processing methodologies of interest include: correlation, wavelet transforms, mathematical morphology and neural networks. Hardware implementations will be emphasized on Fourier optics and customized DSP.

Tien-Hsin Chao	(818) 354-8614	tien-hsin.chao@jpl.nasa.gov

Machine Vision Systems — Development of algorithms for visual shape and motion estimation, object recognition, and pose estimation for applications in space flight and planetary exploration. Such applications include autonomous rendezvous and docking, autonomous landing, robotic maintenance of earth-orbiting spacecraft, and planetary rovers. Also interested in development of advanced imagers and high performance, low power, onboard computing hardware for these applications

Larry Matthies	(818) 354-3722	larry.h.matthies@jpl.nasa.gov

Vis/UV/X-ray Sensor Technology — Investigation of advanced materials and devices for the detection of electromagnetic radiation in the visible through low-energy x-ray wavelength regime. Development of high-performance backside-illuminated charge-coupled devices, rejection and anti reflection coatings, and space science instrument concepts. Research on wide bandgap semiconductor materials for solar-blind detectors.

Siamak Forouhar	(818) 354-4967	siamak.forouhar@jpl.nasa.gov

Infrared Detectors — Investigation of III-V based new device structures for infrared radiation detection. The research involves studying intersubband absorption, interband absorption and carrier transport properties in III-V superlattices and multiquantum well structures.

Sarath Gunapala	(818) 354-1880	sarath.d.gunapala@jpl.nasa.gov

Advanced In-Situ Sensors and Devices — Design, research, and development of advanced miniaturized sensors for planetary exploration and earth monitoring. Technologies under development include physical sensors (micromachined seismometers, hygrometers, electron probes, micro Lidars and dust analyzers, geochronological dating methods, pressure transducers, IR thermal detectors) and chemical sensors (Micro-NMR, capillary electropheresis on a chip, amino acid and fatty acid detection, X-ray diffraction and micro-spectroscopic analysis). This also includes the systems necessary for sample collection, calibration, and data collection.

Timothy Krabach	(818) 354-9654	timothy.n.krabach@jpl.nasa.gov

MEMS Technology — Research and development in micromachining technology, modeling, reliability, and integration. The microfabrication facilities in MDL are used extensively to develop innovative fabrication approaches to demonstrate next-generation micromechanical devices for a variety of micro-sensors and micro-actuators.

William C. Tang	(818) 354-2052	william.c.tang@jpl.nasa.gov

Integrated Space Microsystems — Research and development of advanced microelectronics computing and avionics systems technologies, including: Semiconductor technologies for scaled voltage, power, and feature size; Ultra Low Power devices, architectures, and systems; Radiation Tolerant electronics, architectures and systems design; Advanced flight computer design, performance modeling, benchmarking and evaluation; Memory systems for both volatile and nonvolatile storage (SRAM/DRAM/Flash, Holographic storage, etc.); Low Power I/O architectures; high-speed interconnect networks; commercial off the shelf architectures for low-cost system applications; Fault Tolerant systems, including hardware and software fault-tolerance using off-the-shelf components; Modeling and analysis of FT systems. Design Automation techniques for Design for Testability and Built In Self Test; Advanced Microelectronics Packaging, such as chip stacking in 3D, MCM's, and MCM stacking in 3D; Collaborative engineering, integration and testing.

Integrated systems on a chip, including integrated power management, data storage and processing, sensor technology, and RF communication technology. Advanced computing concepts, including quantum computing, quantum dots, innovative computer architectures, biologically inspired systems, molecular nanotechnology, atomic scale technology, etc.

Leon Alkalai	(818) 354-5988	Fax: (818) 393-5007	leon.alkalai@jpl.nasa.gov

Advanced MultiMode Avionic Design — Development of advanced designs that incorporate analog/digital optoelectronics and/or RF on one substrate. Development of the design tools necessary for such devices. Development of specific avionic equipment utilizing such devices (I/O interfaces, switching circuitry, etc.).

Mark Underwood	(818) 354-9731	Fax: (818) 393-4944	mark.l.underwood@jpl.nasa.gov

Data Storage Technology — Investigation of hybrid magnetic-semiconductor memory devices for the development of memory and data storage modules for space applications. Development of design, simulation and experimental capabilities to validate technologies for space data storage applications. Investigation of magneto-optical and optical data storage technologies, including holographic data storage, for space mass-storage applications.

John Klein	(818) 354-2603	john.w.klein@jpl.nasa.gov

Magnetic Device Technology — Investigation of magnetic devices such as microinductors, micro-transformers, and magnetically actuated devices for space applications.

John Klein	(818) 354-2603	john.w.klein@jpl.nasa.gov

Concurrent Processing Using Analog/Digital Hardware — Research in architectures and algorithms related to neural networks, fuzzy logic, genetic algorithms, cellular automata, evolvable hardware, and other similar VLSI-based armlog and digital parallel processing devices.

Taher Daud	(818) 354-5782	taher.daud@jpl.nasa.gov

Advanced Computing Technologies — Research in algorithms, architectures, and technology related to artificial neural networks, fuzzy logic, genetic algorithms, evolvable hardware, expert rule processor, and other similar VLSI-based analog and digital parallel processing devices. In addition, research in biocomputing architectures and technology development are also of interest. Applications to target and image processing, on-board adaptation, 3-dimensional VLSI architectures, and similar high speed and low power multichip module technology approaches are of keen interest as well.

Taher Daud	(818) 354-5782	taher.daud@jpl.nasa.gov

Neural Network Algorithms — Advanced neural algorithms for spacecraft control, autonomous rendezvous, docking, and landing. Development of feature extraction and tracking algorithms for small body spin vector and shape estimation. Application of neural networks to multisensor integration.

Benny Toomarian	(818) 354-7945	nikzad.toomarian@jpl.nasa.gov

MECHANICAL SYSTEMS

The Mechanical Systems Division carries out research in propulsion, cryogenics, structures, mechanical systems, materials, and thermal sciences. Research opportunities exist in materials with unique electro-mechanical and optical properties, active control of structural shape and vibration, inflatable structures, chemical sensors, cryogenic cooling systems including sorption coolers and integration of mechanical coolers with instruments, advanced superfluid helium cryostats, electric propulsion, autonomous mobility systems and remote sample acquisition.

Thomas Luchik	(818) 354-3165	thomas.s.luchik@jpl.nasa.gov

INFORMATION SYSTEMS DEVELOPMENT AND OPERATIONS

The Information Systems Development and Operations Division performs research, development, planning, and operations related to ground-based information systems for spacecraft missions and other tasks in the national interest. Activities include:

(1) mission operations engineering, technology, control, and data management,
(2) information systems engineering, technology, and services,
(3) ground data systems applications engineering and development,
(4) space and institutional networks engineering, and
(5) advanced information systems technology development and applications.

Research areas include:

(1) advanced automation for spacecraft and ground system operations,
(2) machine learning and applications,
(3) simulation, modeling, and expert systems,
(4) high-rate, high-capacity distributed information systems,
(5) software productivity and reliability,
(6) high-performance computing and supercomputing, and
(7) low-cost mission operations.

David Atkinson	(818) 393-2769	david.j.atkinson@jpl.nasa.gov

OBSERVATIONAL SYSTEMS

The Observational Systems Division is responsible for the conception, design, engineering, development, and implementation of a variety of scientific instrumentation for space flight applications. Key elements in the division are digital image processing research and development for space science, environmental and Earth resources applications, and the management and archiving of science data.

Mary Bothwell	(818) 354-2399	mary.bothwell@jpl.nasa.gov

Interferometry Systems & Technology – To be the world leader in the development of advanced space and ground-based interferometry and large optics systems and associated technologies to meet the technology, engineering, and science needs of the related JPL tasks, projects and programs. This includes interferometer and optical systems/subsystems engineering; requirements definition; architecture design; system and sybsystem modeling; performance prediction, analysis, and validation, and instrument development; design, analyze, develop, integrate, and evaluate technology, embedded/real-time and end user software development, electronics design and optics.

Steve Macenka	(818) 354-6066	steven.a.macenka@jpl.nasa.gov

Space Microsensors Technology – Research and development in *in-situ* sensors, superconducting materials and devices, semiconductor lasers, quantum Well Infrared Photodetectors (QWIPS) and focal plane arrays, diffractive optics, Microelectromechnical Systems (MEMS), UV focal plane arrays, and nanostructures. Specific research topics include efforts in microfluidics, carbon nanotube-based devices, bionanotechnology, superconducting detectors, spin-based semiconductor devices, quantum computing, LIGA, micro-electroplating, micro valves and actuators, microgyroscopes, MEMS-based adaptive optics, bio-MEMS, low-energy particle detection, micropropulsion, antimonide detectors and lasers, and pick-spacecraft. Facilities include a 38,000 square foot state-of-the-art microdevice fabrication facility and a high-resolution JEOL electron beam lithography system.

Carl Ruoff	(818) 354-3599	carl.f.ruoff-jr@jpl.nasa.gov

Imaging and Spectrometry Systems — Technology development and application for advanced imagers, spectrometers and analytical instruments for remote sensing and in-situ environments. Provides technology and tools for end-to-end modeling/Simulation of missions and experiments. Develops advanced algorithms and software for scientific data visualization, analysis and modeling calculation, including state-of-the-art work in parallel and network computing. The Section is in the forefront in research and advanced development of instruments for in-situ analysis of chemical species including mass spectrometry, scanning electron microscopy, X-ray diffractrometry.

Ray Wall	(818) 354-5016	ray.j.wall@jpl.nasa.gov

Microwave, Lidar, and Interferometer Technology — Provide technology and research instrument development as well as flight instrument engineering. Expertise, ranging from device physics to system-level operations of flight instruments, responds to NASA needs for improved remote and *in-situ* sensing instruments for terrestrial, planetary, and astrophysical observations. Development of state-of-the-art technology needed by JPL/NASA for microwave, millimeter-wave, and submillimeter-wave observational instruments, as well as for laser observational instruments. Also conducts experiments with the advanced technology instruments and analyzes their performance capabilities.

Bob Menzies	(818) 354-4317	robert.t.menzies@jpl.nasa.gov
Martin Herman	(818) 354-8541	martin.herman@jpl.nasa.gov

Space Instruments Implementation — Conception, design development and implementation of remote and in-situ sensing systems to enable both NASA and other agencies space science investigations and observations. Specifically, the lead organization responsible for space flight hardware implementation of observational systems. Performs engineering development, test and calibration for flight instrument systems, including optical imaging and spectrometer systems, microwave and submillimeter radiometer systems, and in-situ chemical analysis and electron microscopy instruments for remote and landed science investigations.

Valerie Duval	(818) 354-5786	valerie.g.duval@jpl.nasa.gov

Science Data Processing Systems — Provides the unique combination of expertise in information technology and the physical sciences to develop end-to-end science data processing systems in support of Planetary, Earth, and Origins missions. Software and systems are developed to meet the data processing requirements of the science instrument life-cycle – from test and calibration through flight and data archive.

Sue Lavoie	(818) 354-5677	susan.k.lavoie@jpl.nasa.gov

Science Data Management and Archiving — Design, develop and operate science data systems for producing archive data products from data generated by NASA's observational instruments. Design, develop and operate data catalog and data access systems using DBMS and hypertext based technologies (such as those underlying the World Wide Web). Implement NASA's educational outreach objectives through the development of multimedia-based educational products available on CD-ROMs or on the WEB. Lead in R&D for archive product and distribution technologies such as CD-ROMs and access to massive data archives.

Yolanda Oliver	(818) 393-2575	yolanda.j.oliver@jpl.nasa.gov

ENGINEERING AND MISSION ASSURANCE

Microelectronic Radiation Hardness Assurance — Work is focused on research and testing of the reliability of electronic parts in the harsh radiation environments experienced by NASA spacecraft. Current activities include investigations into radiation effects in electronics and photonics caused by heavy ions characteristic of galactic cosmic rays, electrons, protons and 60Co gamma rays; simulation of single event effects (SEE) by 252Cf; and radiation testing of parts for NASA flight projects. In addition, evaluations are performed of test methodologies and process technologies used to produce reliable, radiation-tolerant microelectronic circuits such as application specific integrated circuits (ASIC's), field programmable gate arrays (FPGAs) and large memories (SRAM's, DRAM's).

Charles Barnes	(818) 354-4467	charles.e.barnes@jpl.nasa.gov

Systems Assurance — Systems Assurance conducts research in wide range of areas concerned with the quality and reliability of spacecraft systems. Research opportunities exist in the modeling, analysis, and simulation of the natural and induced spacecraft mission environments and of their effects on spacecraft systems, subsystems, and individual components. Software reliability analyses and metrics definition are other areas of rapidly growing research. Specific issues associated with software, spacecraft sensors, control systems, and other flight hardware are of interest.

A. G. Brejcha	(818) 354-3080	albert.g.brejcha@jpl.nasa.gov

Reliability Engineering — Develops reliability and environmental design, analysis, and test requirements for all JPL flight projects. Reliability activities include electrical and mechanical analyses and environmental requirements activities include: thermal, dynamics, electromagnetic compatibility, and natural space environments. Natural environments include solar and planetary thermal conditions, micrometeoroids and space debris, and space plasma. Induced environments include vibration, acoustic, pyrotechnic shock, and thermal loads, electromagnetic effects, spacecraft charging, etc.

J. F. Clawson	(818) 354-7021	james.f.clawson@jpl.nasa.gov

Software Product Assurance — Software Product Assurance has the objective to help ensure the operational integrity of the software developed for JPL systems, and evaluates the operational requirements, the acceptability and readiness of all software prior to delivery. It also researches advanced techniques in software engineering, human computer interface, software safety, and metrics, and performs technology transfer to techniques tailored for the JPL and NASA environment to improve the quality of software within JPL and NASA.

R. Santiago	(818) 354-2452	richard.santiago@jpl.nasa.gov

MULTIMISSION OPERATIONS SYSTEM OFFICE (MOSO)

The Multimission Operations Systems Office integrates the development of hardware and software tools to provide efficient and effective multimission operations systems and services to JPL's planetary science projects in order to minimize the cost of mission operations and data analysis. These systems and services include spacecraft analysis and navigation, mission planning and sequencing, science analysis, mission control and data management, computers and communications, and telemetry.

Terry Linick	(818) 354-3161	terry.d.linick@jpl.nasa.gov

HPCC/Earth and Space Sciences (ESS) Project — JPL is interested in research that will lead to new parallel computational methods for distributed memory supercomputing architectures. Areas of particular interest include parallel visualization and analysis of massive data sets, methods for writing portable parallel applications and algorithms, performance optimization, and novel parallel numerical techniques. This work is in support of ESS Grand Challenge science applications, which include multidisciplinary modeling of Earth and space phenomena, and analysis of data from remote sensing instruments.

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JOHNSON SPACE CENTER

Program Administrator
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Mission

The mission of the Johnson Space Center is the expansion of a human presence in space through exploration and utilization for the benefit of all. The Center is also responsible for leadership in the field of astromaterials. JSC is the Center of Excellence for Human Operations in Space. This means that JSC provides national leadership and technological preeminence in those capabilities and technologies that support human operations in space. Principal areas include:

- Human spacecraft and habitat design and development
- Human space life sciences
- Flight crew operations
- Mission operations and training
- Planetary surface systems for human operations
- Astromaterials collections, curation, and analysis

JSC is the Lead Center for Space Shuttle Program, International Space Station Program, Space Operations, Biomedical Research and Countermeasures Program, and the Advanced Human Support Technology Program. Agency-wide assignments include Extravehicular Activity (EVA), Robotics Technology Associated with Human Activities, Space Medicine, Technology Utilization on International Space Station and Exploration Mission Planning and Design.

ENGINEERING

Advanced Life Support Systems — Current research involves development of regenerative (low use of expendables) human life support systems for long duration space missions including the International Space Station as well as other near-Earth exploration locations. Research must address either or both microgravity and hypogravity environments of vehicles or planetary surfaces. Such systems will consist of components that utilize both physicochemical and biological processes to perform the life support functions. Included in these functions are air revitalization, which includes carbon dioxide removal, oxygen generation, and trace gas contaminant control. Water recovery functions include urine treatment, hygiene water processing, and potable water polishing. Food production functions involve crop production using both hydroponics and solid substrate culturing systems. Solid waste processing involves de-watering, volume reduction, and safe storage as well as recovery of other resources from solid wastes generated in space-based human vehicles and habitats. Thermal control research areas include light weight, high efficiency heat pumps and unique heat rejection devices to aid in room temperature heat rejection for advanced missions; theoretical studies and analysis techniques for advanced two phase thermal management systems; and automated monitoring and control, and fault detection methods for advanced two phase thermal management systems. Additionally, integration of these systems into a functioning regenerative life support system via highly automated control and monitoring systems is critical to current development efforts.

Research opportunities exist in chemistry, physics, horticulture and plant physiology, soil science, water chemistry, and environmental, chemical, biological, mechanical, computer, and systems engineering disciplines. Opportunities exist for studies of dynamic computer analysis and simulation methodology for hybrid physicochemical and biological systems and development of mathematical models of candidate processes to be integrated into regenerative life-support systems. For additional information, see: http://advlifesupport.jsc.nasa.gov/.

D. L. Henninger	(281) 483-5034	dhennin1@ems.jsc.nasa.gov

Guidance Navigation and Control — Research opportunities exist for development of technologies supporting definition, evaluation and development of guidance navigation and control systems for space flight programs.

David Kanipe	(281) 483-4861	david.b.kanipe1@jsc.nasa.gov

Integrated Design and Simulation Environments — Define integrated simulation architectures that will allow for dynamically interfacing of multiple simulations and hardware elements across a Wide Area Network (WAN) and keep them synched. For example, guidance, navigation and control (GN&C) flight software is running in one building and the reaction control jets are set-up in another. Instead of moving the two pieces to a common location and then integrating them, create an architecture that would allow the GN&C flight software to run closed-loop while separated in different locations. Define technology for integrated design environments that allow design tools to be used across multiple platforms and facilities. Create multidiscipline design architectures that allow design tools from different disciplines, developed for different platforms, and in different geographic environments to function as an integrated unit.

Dave Petri	david.a.petri1@jsc.nasa.gov

Landing Hazard Avoidance — Design a landing hazard avoidance system for spacecraft landers. Selected landing sites may exhibit hazards such as slopes, ravines, rocks, etc., which should be detected and avoided autonomously. Development of sensor systems, actuator requirements, avoidance maneuver guidance and control algorithms, and landing performance assessment is required. Systems should be demonstrated using simulation and subscale flight tests. Sensitivity analyses to system errors and environmental dispersions should be performed.

Bedford Cockrell	bedford.f.cockrell1@jsc.nasa.gov

Parafoil Performance — Research to investigate and determine the aerodynamic stability characteristics for a parafoil and payload system of large scale applicable to spacecraft landing. Of particular interest are attitude damping derivatives, as well as the roll coefficients due to sideslip and yaw rate. Approaches may include literature searches, analytical techniques, subscale ground testing, and/or flight testing. Subsequent evaluation of the longitudinal and lateral-directional dynamic modes of the typical large scale parafoil-payload system should be pursued to determine stability characteristics, flap input response and gust response dynamics. Research opportunities also exist in the technical field of aerodynamics as applied to the modeling of the opening process of ram-air lifting parachutes. The research will include developing an analytical math model describing the canopy opening inflation process for each of several reefing stages. The analytical model will be developed in parallel with complimentary wind tunnel and scaled model flight tests. Technologies involved include aerodynamics, flight mechanics, fluid dynamics, microsensors, structures, aeroelasticty, ground and flight testing, computer coding, and computational fluid dynamics. The math model produced will be used to predict the opening process, to define optimum canopy characteristics, and to establish constraint boundaries.

Rick Barton	richard.l.barton1@jsc.nasa.gov

Advanced Flight Control — Develop the algorithms, sensor requirements, and actuator requirements for a robust flight control system for use for advanced mission and system designs for Human Exploration of Space. Using advanced techniques such as neural networks, adaptive techniques, or learning algorithms, design a flight control system for proposed vehicles capable of handling large environment uncertainties. These systems include vehicles using low thrust ion or plasma thrust as well as high performance powered and atmospheric flight.

Mark Hammerschmidt	mark.m.hammerschmidt1@jsc.nasa.gov

Nanotechnology — Opportunities exist to research applications and bulk production of single-walled carbon nanotubes. Revolutionary designs and concepts are sought for using the extraordinary properties of nanotubes in areas such as high strength materials and composites, energy storage, nanoelectronics, and thermal protection, among others. These ideas should focus on space applications for long duration missions. Possible bulk production techniques may include electric arc, gas phase, or solar heating as continuous growth methods. Also of interest are growths of continuous aligned nanotubes for applications such as composites.

Brad Files	(281) 483-5967	brad.files@jsc.nasa.gov

In-Situ Resource Utilization (ISRU) — The concept of "living off the land" by utilizing the indigenous resources of the Moon, Mars, or other potential sites of robotic and human exploration is called **In-**Situ Resource Utilization (ISRU). The chief benefits of ISRU are that it can reduce both the cost and the risk of robotic and human exploration by decreasing Earth launch mass and by increasing self-sufficiency and surface mobility. The research area includes: (1) collection, separation, and conditioning of in-situ atmospheric, soil/rock, and drilled resources; (2) manufacturing of propellants, fuel cell reagents, and life-support gases and water; (3) collection, liquefaction and/or compression, storage, and transfer of manufactured fluids; and, (4) sensors and software to enable autonomous control of ISRU resource and chemical processing activities.

Gerald B. Sanders	(281) 483-9066	gerald.b.sanders1@jsc.nasa.gov

Fluid and Vehicle Attitude Control Systems — Attitude control systems research in the areas of: (1) low gravity earth storable and cryogenic fluid behavior, acquisition, and fluid quantity/flow gauging; (2) pulsing engine design, combustion modeling, and stability analysis; (3) high temperature combustion compatible materials; (4) on-orbit component and system health monitoring; and (5) high performance/long life fluid control components and sensors.

Eric Hurlbert	(281) 483-9016	eric.a.hurlbert1@jsc.nasa.gov

Electro-Mechanical Systems (EMAs) — Research into electro-mechanical systems (EMA) for aerodynamic surface control, mechanical system actuation (i.e., doors, umbilicals, etc.), fluid component actuation, and electrical auxiliary power units for hydraulic systems. This research includes high performance electrical motors, controllers, gear trains, fault tolerance, and associated instrumentation.

Landon Moore	(281) 483-9002	landon.moore1@jsc.nasa.gov

Electrical Power Systems — Research area includes electrical power generation (energy conversion), energy storage, and electrical power distribution and control. Specific topics may include: (1) safe application of high density, long life, battery chemistries for manned spacecraft; (2) high current density, long life fuel cells for manned spacecraft applications; (3) specification of stability requirements on source and load converters for large, manned spacecraft regulated power distribution systems, including topologies.

Bob Egusquiza	(281) 483-8284	roberto.m.egusquiza1@jsc.nasa.gov

Robotic Technologies — Development of emerging robotic technologies, such as (1) robotic end effectors and manipulators with special emphasis on small scale, dexterous and anthropomorphic robots; (2) human-robotic interfaces for telepresence control of robots, including tactile/force feedback techniques, helmet mounted vision displays, stereoscopic vision displays, and visual and non-visual techniques for following human operator input commands; (3) robotic control software including force/torque feedback, adaptive control, grasping techniques and multiarm control (for both kinematically sufficient and redundant systems); (4) robotic sensors including contact and proximity sensors for collision detection and avoidance, limiting forces, mapping, etc.; and (5) machine vision and perception including pattern recognition, feature extraction, pose estimation, object tracking, image registration, visual inspection, and landmark navigation. Application of these technologies will be applied to current technology projects including the development of free flying robotic inspection space vehicles, dexterous anthromorphic maintenance and servicing robots and robotic assistants to suited astronauts during planetary science exploration.

Chris Culbert	(281) 483-8080	christopher.j.culbert1@jsc.nasa.gov

Intelligent Systems for Robotics — Development of intelligent systems technologies to support the design, development and operation of space robotic systems, such as (1) Computer Software Architectures to Support Intelligent Robotic Systems for Human/Robot Teams In Space; (2) Realtime Intelligent System Monitoring and Control; (3) Failure Detection, Diagnosis and Reconfiguration; (4) Intelligent System Modeling and Analysis; (5) Automated Design Knowledge Capture; (6) Automated Planning and Scheduling; (7) Fault Tolerant Robotic Control and Adaptive Control of Multimodal High Degree of Freedom and Nonlinear Systems; (8) Intelligent Pattern Recognition and Trend Monitoring; (9) Realtime Expert Systems; and (10) Adaptive and Intelligent Control (including Machine Learning, Neural Networks, Fuzzy Logic). Application of these technologies will be applied to current technology projects including the development of free flying robotic inspection space vehicles, dexterous anthromorphic maintenance and servicing robots and robotic assistants to suited astronauts during planetary science exploration.

Robert Savely	(281) 483-8105	robert.t.savely1@jsc.nasa.gov

Flow Diagnostics — Flow diagnostics and measurement techniques are being developed for both flight and high-enthalpy arc jet flows used for thermal-protection system testing. Some techniques of interest for arc diagnostics are laser-induced fluorescence (LIF), LIF anemometry, emission spectroscopy, laser-Raman scattering, and gas **sampling** probes with mass spectrometry. An understanding of flow fields is required for gas/surface interaction studies, including surface catalytic atom recombination and the associated diagnostics of the excited molecules produced. Johnson Space Center has a 10 Mw arc tunnel facility with some laser and spectroscopic diagnostic equipment. More instrumentation for the facility is being planned.

C. D. Scott	(281) 483-6643	c.d.scott1@jsc.nasa.gov

Aerothermodynamics — RESTRICTED ELIGIBILITY: This research is open only to US citizens and Legal Permanent Residents.

Aeroheating to high-speed reentry and aerobraking vehicles depends significantly on nonequilibrium thermal and chemical rates. Included is the need to understand the kinetics of nonequilibrium radiation in shock layers and in wakes. Techniques for coupling of ablating surfaces with the external flow are needed. Engineering assessment techniques and detailed, physically accurate models require study and development. Physical data such as chemical reaction rates in multitemperature nonequilibrium flows are of interest; transport properties for reacting and partially ionized gases are needed. The chemistry and aerodynamics of the Martian atmosphere is also of interest. Models for catalytic atom recombination on surfaces also need to be developed for both air and the Martian atmosphere. CRAY, SGI, and HP workstation computer systems are available for computations.

C. D. Scott	(281) 483-6643	c.d.scott1@jsc.nasa.gov

Communications and Tracking System Design — RESTRICTED ELIGIBILITY: This research is open only to US citizens and Legal Permanent Residents.

This research task will involve the design of end-to-end communications and tracking systems for use in a growth Space Station and lunar/Mars/Earth links. These systems will require many types of communications links carrying scientific data, as well as voice, television, and text and graphics. The tracking requirements will include rendezvous radar, traffic-control radar, proximity-operations radar, and automatic-docking measurements.

The techniques/systems to be considered include (1) radio-frequency interference/ electromagnetic interference mitigation, (2) digital voice/High Definition television data processing and distribution, (3) voice recognition synthesis, (4) multiple-function/multiple-beam antenna configurations and waveguide arrays, (5) frequency-reuse and spectrum-efficient modulation schemes, (6) automated vehicle-terminal guidance systems, (7) multiple-object radar-tracking techniques, and (8) programmable transceivers.

The research under this task will concentrate on systems design involving technology/techniques in communications/tracking hardware and signal processing.

G. D. Arndt	(281) 483-1438	g.d.arndt1@jsc.nasa.gov

Millimeter-Wave Technology of Advanced Antenna Systems — This research task will involve laboratory research and systems analyses of millimeter-wave technology as applied to spaceborne communications and antenna systems. This task is directed towards hardware breadboard design and testing of antennas, and associated front-end (microwave integrated circuits/monolithic microwave integrated circuits) electronics. Applications include multiple-beam antennas for communicating with low-Earth-orbiting satellites or geosynchronous relay satellites and high-resolution, orbital debris radar-tracking antennas.

The results of this research will aid in the design of advanced antenna/electronic systems to be used on future space vehicles and the Space Station.

G. D. Arndt	(281) 483-1438	g.d.arndt1@jsc.nasa.gov

Flight Data Systems — Research opportunities exist for the following areas of interest: High speed, radiation tolerant avionic systems; micro electronic hardware components to enable light weight, low-power, ultra-reliable avionic systems for long duration manned space missions; application of standards to spaceflight data system architectures; fault-tolerant standards solutions; real-time object-oriented software; application of commercial hardware solutions to space flight environments; radiation characterization analysis hardware; mixed signal ASIC design; fault-tolerant backplanes; and distributed processing for sensor signal characterization of impending failures. Laboratory facilities exist to support real-time software and fault-tolerant research.

William E. Teasdale	(281) 483-0126	william.e.teasdale1@jsc.nasa.gov

Advanced Habitation Systems — The physiological and psychological interactions of habitat environment factors and habitability such as crew hardware, functional and spatial arrangement, color, patterns, temperature, gravity, and social interaction are being investigated to understand the long term affects on humans for remote and isolated operations for space station and future long duration space missions on the Moon and Mars. The goal is to understand architectural problems and thus solutions to enhance crew morale and productivity. The human built environment (architecture) has always influenced human emotion and perception of space. For this reason, research is needed to address the built environment on space station, in space flight and on the planetary surface.

The research area includes advanced habitation outfitting and construction technology to enable the Human Exploration and Development of Space Enterprise to meet the demanding environment of faster, better, cheaper. Research on architectural functional and spatial arrangement, color, patterns, temperature, gravity, and social interaction are being sought. Space and planetary habitation, pressure structures and unpressurized shelters are being sought out for innovative design solutions that combine high strength and light weight materials, along with the reliability, durability, repairability, radiation protection, packaging efficiency and life-cycle cost effectiveness. Advanced habitability outfitting such as crew quarters, galley, wardroom, waste and hygiene, and laundry systems are being sought out. Advances in material developments and manufacturing techniques that enable the structure to “self-heal,” and the emplacement, erection, deployment or manufacturing of habitats in space or on the Moon and Mars are considered enabling technologies for the evolution of humans into space and the eventual settlement on Mars. Integration of sensors, circuitry and automated components to enable self-deployment and “smart” structures are considered necessary to allow the habitat to operate autonomously. The objective is to create an advanced habitat that becomes a “living” structure that not only runs autonomously, but also has self-healing capability. Novel methods and techniques for fully integrated skin and sensors/circuitry that enables “smart” structures that autonomously detect, analyze, and correct (repair) structural failure. Methods of integrating miniaturization technology into the habitat skin, thus reducing weight and increasing self-autonomy.

K. J. Kennedy	(281) 483-6629	kriss.j.kennedy@jsc.nasa.gov

LIFE SCIENCES

Nutritional Biochemistry Laboratory Research — Space flight alters the metabolism and/or utilization of several nutrients. These alterations, observed during both real and simulated (e.g., bed rest) space flight, appear to be related to other physiologic changes that occur during space flight and thus may indicate shifts in metabolism that affect nutrient requirements.

Research is focused on human nutritional requirements for extended-duration space flight. Areas of particular interest include the consequences of microgravity-induced changes in bone and calcium; alterations in micronutrient metabolism and requirements during long-term space flight; interactions of radiation with nutrition (e.g., ascorbic acid, iron, vitamin E, and selenium); the influence of exercise on nutritional requirements; and alterations in the digestion and absorption of nutrients in space.

The Nutritional Biochemistry Laboratory facility has the capability to analyze substances for all major nutrients and biochemical analytes. Standard procedures are available: inductively coupled plasma-mass spectrometry high-pressure liquid chromatography, atomic absorption, ion chromatography, enzyme-linked immunoassay and radioimmunoasasay. Research efforts are underway to determine the changes in calcium metabolism during space flight. A comprehensive nutritional assessment protocol is also implemented as a medical requirement for long-duration crewmembers. Efforts are also ongoing to develop appropriate techniques to measure changes in nutrition and metabolism during space flight. The laboratory is particularly concerned with defining these changes, determining when they may be detrimental to crewmembers, and developing appropriate countermeasures for any detrimental changes. When appropriate, research will be directed to the amelioration of space flight induced physiological changes through nutritional countermeasures.

Although Space Shuttle and International Space Station flight-experiment opportunities are available to develop and verify related experimental support protocols, the resources for these platforms are extremely limited. The laboratory coordinates its efforts with both intramural and extramural collaborators. Other in-house teams include biochemistry, hematology, immunology, endocrinology, and exercise-physiology laboratories. Clinical studies are conducted using ground-based simulations such as bed-rest research projects.

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Recycled Water: Chemistry, Disinfection, Inflight Monitoring, and Toxicology — Water reclamation from urine, wash water, and humidity condensate and reuse for potable and hygiene purposes is considered a key feature of long-duration spaceflight in order to avoid massive launch/resupply penalties associated with on-board drinking and hygiene needs. A variety of primary reclamation technologies and a number of pretreatment and post-treatment schemes to minimize or eliminate contaminants from the product water are being developed. The quality of the product water, particularly organic content, is specific to the unique combination of reclamation processes used. Certification of reclaimed water for direct reuse by humans presents major technical problems not encountered in terrestrial water systems. Because of the direct reuse aspects, aggressive efforts are needed to bridge the gap between the technology development efforts and biomedical requirements in order to verify that reclamation processes that are safe and reliable.

The goals of this activity include the following: (1) determination of the contaminant composition of source and product waters from the variety of reclamation processes being developed under both nominal and off-nominal conditions; (2) development of analytical procedures to support identification and quantification of the organic constituents in recycled water; (3) development of analytical procedures to measure halogen species in waters, with emphasis on iodine disinfection; (4) development of microgravity-compatible monitoring capabilities that minimize expendable requirements, which will be needed to verify the water quality before it is used; (5) determination of relative toxicity of detected organic constituents and the establishment of respective MCLs; (6) definition of quality specifications for water reclaimed for direct reuse from humidity condensate, urine, and wash water; (7) identification and quantification of disinfection products associated with halogen disinfectants; (8) development of advanced water reclamation and post-treatment technology for organics removal and microbiological control; (9) development of methods for remediating contamination events in spacecraft water distribution systems; (10) development of water potability bioassay techniques for recycled water that are potentially adaptable to inflight application; and (11) development of an overall plan by which reclaimed water can be certified acceptable for human consumption and hygiene uses.

This activity will be performed in the water-quality laboratory in close association with the toxicology and microbiology laboratories.

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Immune Responses to Space Flight — The primary concern of the Space Microbiology Program is to ensure the health, safety, and productivity of astronauts. This requires careful diagnostic evaluation of astronauts and their environments before and after missions. Developing microbiological diagnostic technologies for use during a space mission is another important aspect of maintaining crew health and productivity. Microbial analysis of the air, surfaces, water, food, experimental animals, and payloads is included in the environmental assessment.

The Microbiology Laboratory defines requirements, develops specifications, and evaluates candidate hardware in the areas of clinical and environmental microbiology for use on board manned space systems, including the space shuttle and space station programs.

Intense research areas include developing simple, rapid, and direct methods to diagnose infectious diseases and to determine the effects of different microbial loads on human health in a closed system; investigating the effects of spaceflight on microbial population dynamics, structure, and function; pathogenicity; and susceptibility to antibiotics.

In preparation for longer duration missions, vigorous research focuses on the effect of spaceflight and related factors on the human immune response, particularly the immunology of infectious diseases. Experimental and clinical studies will be used to investigate the effect of spaceflight on the three major arms of the immune system: cellular, humoral, and innate immunity. Specific areas of investigation include neutrophil and monocyte function (e.g., chemotaxis, adhesion), natural killer cell and T-cytoxic cell function, antibody response to specific antigen challenges, and reactivation of herpes viruses in response to spaceflight.

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Cell Science and Immunology - The cellular and molecular mechanisms by which space flight alters human physiology are poorly understood. Crewmembers experience immune system changes, muscle and bone loss, neurological alterations, and other changes in body systems. To optimally develop techniques that prevent or alleviate the deleterious effects of space flight, we must determine which cellular processes are altered by microgravity. JSCs Cellular/molecular Research Laboratories focus on the effects of space flight on immune cell function both in vivo and in vitro. We also investigate the response of other types of cultured cells (e.g., bone cells and endothelial cells) to altered gravity environments. The laboratory is equipped for tissue culture and general biochemistry/molecular biology studies, and contains two flow cytometers, light/fluorescence microscopes, digital image systems, and two scanning electron microscopes. In addition, the laboratory has direct access to a confocal microscope.

Results from previous studies have indicated a dysregulation of the immune system associated with space flight. Observations in several laboratories have demonstrated significant alterations in circulating lymphocyte populations following space flight. Functional studies are being initiated to investigate the effect of these alterations on immune competence. These studies will include the examination of T- and B-cell activity, accessory cell function, and changes in immunoregulatory factors and lymphocyte trafficking. In addition, a number of investigators have shown depressed in vitro activation of lymphocytes with space flight. Detailed studies of the effects mechanical forces on the cell-cell interactions, signal transduction pathways, and transcriptional changes involved in lymphocyte activation are under way to delineate the mechanisms that are altered in microgravity. These studies utilize hypergravity and clinorotation (a microgravity model system) models to examine the effects of gravity and mechanical forces at the cellular and molecular level. Understanding the role of such forces in signal transduction, cytoskeletal function, and cell cycle regulation will provide knowledge relevant to cellular activation, movement, shape, adhesion, movement of organelles, gene expression, and proliferation. Knowledge of gravity-induced alterations in these characteristics at a cellular level will provide a mechanistic foundation to improve our understanding of the physiological effects observed during space flight.

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Biotechnology Cell Science Program — This program uses the microgravity environment to help us understand the biological processes and to develop the technology required to overcome gravity-based limitations in cell culture and tissue engineering. We have developed bioreactors for the culture of cells using well-controlled process parameters and reduced levels of hydrodynamic shear stress, which simulates the low-gravity conditions of space to the extent possible on Earth. Bioreactors suspend cells with minimal shear forces through rotation of the cylindrical, fluid-filled culture vessel. Mammalian cells cultured in this environment aggregate and grow into three-dimensional arrays, and the cultured cells display differentiation markers similar to those found in corresponding mammalian tissue. The advantage of these bioreactor systems is that tissue-like cell arrays are suspended in a well-mixed aqueous medium that facilitates nutrient transfer and dispersion of wastes, and also makes it possible to isolate potentially novel factors. Ground-based studies using the NASA bioreactors have demonstrated that both normal and neoplastic cells and tissues recreate many of the characteristics that they display in vivo.

The Program has three major goals concerning mammalian tissues culture: (1) to accelerate the development of a three-dimensional tissue culture system using rotating-wall bioreactors, (2) to define and characterize mammalian cells and tissues that benefit from a low shear environment, and (3) to use the microgravity environment of space as necessary to surmount gravity-induced obstacles to the propagation of complex tissues.

Current research areas include effects of reduced levels of mechanical and hydrodynamic shear; the effects of spatial co-location of participating cell populations; the role of mass transport on cellular propagation and tissue assembly; the effects of culture media (e.g., growth factors) on cellular metabolism and waste accumulation; the value of low shear and spatial co-location during culturing; the development of technologies (biosensors for pH, glucose, and oxygen); new tissue culturing methods and strategies; and research into mammalian, plant, and insect culture.

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Radiation Biophysics — The space radiation environment primarily consists of high-energy electrons, protons, and heavy ions from solar wind and galactic cosmic rays, and high-energy particles trapped in the Van Allen Belts by the Earth's geomagnetic field. The radiation health aspects of spaceflight include unique considerations. Of critical importance from a health perspective is the radiobiological assessment of effects resulting from chronic exposure to the high-charge, high-energy (HZE) particles and solar particle events resulting from large solar flares. In addition, dosimetry must be adequate to enable accurate assessment of exposure hazards and must be responsive to a broad spectrum of radiation types and energies. Vehicle design and material selection determine the shielding afforded and must be viewed with respect to weight and volume constraints; furthermore, accurate knowledge of the ambient space-radiation environment and interaction of the radiation with the spacecraft (transport codes) are required to project expected exposures and thus enable mission-duration and mission-profile planning. Studies in progress and projected for the future include (1) biological effects of energetic protons and HZE exposures, especially carcinogenic, cytogenic, and mutagenic effects at the cellular and molecular levels; (2) cellular and molecular mechanism(s) of oncogenic cell transformation by protons and HZE exposure; (3) advanced biomarkers and biological dosimetry; (4) space radiation health physics; (5) biophysical models of HZE effects; (6) radiation protection by chemical and biological agents; and (7) possible increased biological effects resulting from simultaneous exposure to microgravity and space radiation environments.

Acceptable levels of exposure to space radiation are based on a risk-versus-gain consideration. The studies mentioned are critical to a satisfactory space-radiation health program in which exposures and long-term health risks are minimized.

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Biotechnology and Bioprocessing — Microgravity can be used to facilitate the separation and synthesis of medically important biological materials, as well as to enhance the formation of tissue like aggregates in specially designed bioreactors. Theoretical and experimental projects are under way to improve cell culture techniques using normal and neoplastic cell types under microgravity conditions.

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Chronotherapeutics — Space travelers experience ultra-short day/night cycles as the shuttle orbits the Earth every 90 minutes. Medical records and personal communications by astronauts and cosmonauts suggest that sleep disruption is a common occurrence during flights. Extended mission duration and work demands often over-extend crew schedules during flights. Reports of fatigue-related performance decrements in shift workers and other sleep-deprived groups indicate that spaceflight crews may be subjected to similar decreased operational efficiency resulting from alterations in their work-rest efficiency. JSC's pharmacology research group evaluates methods for the assessment of sleep deficits and resulting decrements in work-time alertness and performance. Laboratory activities also focus on designing and developing ground-based and inflight countermeasure strategies for improving sleep quality and health during spaceflight.

Our goal is to generate information and identify ground-based models that can assist in the development of practical, appropriate, reliable, and effective intervention technologies and regiments that can augment health and well being to support sleep-work activity schedules of long duration flights and for a prolonged stay in the microgravity environment. Specific objectives of this investigation are to identify and characterize changes in the physiological and biochemical indices of circadian adjustments during space flights, and to develop and validate effective operational monitoring tools and countermeasures that will improve performance and maintain health of crew members during short and long duration missions.

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Pharmacokinetic Research — Spaceflight induces a number of physiological changes including fluid shifts and cardiovascular deconditioning. While some of these changes were evaluated on earlier missions, others (e.g., changes in gastrointestinal and hepatic function) have not been investigated. Availability of sensitive and flight-suitable methods of evaluation limits implementation of these studies in space. Identification and evaluation of these physiological parameters and resulting changes in the pharmacokinetics and pharmacodynamics of therapeutic agents administered during spaceflight are essential for designing and developing effective treatment regimes for the space medical operations.

Gastrointestinal and hepatic function research focuses on developing simple, noninvasive techniques to conduct these studies in space. We will use ground-based simulation models of microgravity (e.g., antiorthostatic bed rest) to evaluate and validate these techniques for their flight suitability. Using these validated, noninvasive methods, we can also evaluate changes in gastrointestinal and hepatic function during spaceflight.

Pharmacokinetics research includes (1) development of simple and noninvasive drug-monitoring methods that are flight suitable, (2) evaluation of pharmacokinetic changes of drugs during antiorthostatic bed rest, (3) pharmacodynamic implications of these changes, and (4) other changes such as protein binding and metabolism of drugs. Inflight pharmacokinetics and pharmacodynamics are characterized using methods developed in ground-based research. Research in the area of pharmaceutical development involves designing and testing noninvasive and nonparenteral drug dosage forms that are suitable for use in space. We also evaluate sustained release and intranasal dosage forms of antimotion sickness drugs.

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Environmental Physiology/Biophysics Research — The physiological and biophysical interactions of environmental factors such as gas species and their partial pressures, temperature, gravity, decompression and barophysiology, and exercise are being investigated by the Environmental Physiology Laboratory. Experiments involving human subjects, primarily in the area of hypobaric barophysiology, and mathematical models of decompression are currently being pursued. The goal is to reduce the time impact of countermeasures (e.g., oxygen prebreathe) and develop monitoring equipment.

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Pathophysiology of Decompression Sickness — Decompression sickness (DCS) is a malady that occurs when the ambient pressure is reduced. Gas phase formation occurs and situations can progress from subclinical, to DCS, to death. Although it is generally associated with deep-sea divers, DCS can occur in aviators or astronauts during extravehicular activity (EVA).

There is evidence to suggest that the risk of DCS is reduced in microgravity environments. One possibility is a reduction in the forces that participate in stress-assisted nucleation and in vivo gas phase formation. This hypothesis is being tested in human subjects. Objective and quantitative measurements are performed using Doppler ultrasound devices. Final results of these tests will aid in formulating prebreathe procedures for EVA.

Because the current suit utilized for EVA is at a lower pressure than the space cabin, there is a risk of decompression sickness. It is helpful to monitor EVA astronauts for bubble formation, especially in real time. Problems associated with current monitoring systems include fire safety, probe placement, stability of signals, and information transmission from the suit to the monitoring station.

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Psychological Research — This laboratory, which functions under the auspices of the Human Adaptation and Countermeasures Office, is chartered to study those factors that may significantly impact individual and team performance, and psychological health during space missions. The overriding goal of this laboratory is to ensure optimal performance of individual crewmembers and teams during space missions. Another important goal is to ensure the optimal performance of ground support personnel in their relationships with mission crews, and their interactions as a ground-based team. Many factors that affect space crews will have an impact on the ground support personnel and will require appropriate countermeasures.

Suboptimal productivity, lapses in judgment, interpersonal conflict, and other behavioral problems have been encountered on both space flights and ground-based Antarctic missions. A number of factors are presumed to account for these problems, including isolation and confinement. Current research focuses on small group dynamics and team performance in analogue mission crews, development and evaluation of methods for psychological monitoring, and cross-cultural issues related to multinational teams.

The laboratory is equipped with several computers and software for programming, digitizing video and audio inputs, and analyzing data.

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Space Human Factors Research -- With permanent human presence onboard the International Space Station (ISS), astronauts are living and working in microgravity for long durations, facing novel situations for which there is inadequate knowledge of human capabilities. In addition to weightlessness, the confined and isolated nature of a spacecraft environment results in human factors challenges in habitability, workload and human performance. Thus, determining the appropriate set of human factors engineering requirements and identifying critical factors and level of impacts on habitability, workload and human performance are crucial to astronauts' well-being and productivity. In order to achieve this goal, the primary research areas include: (1) human performance modeling and analysis, (2) tools and methods for quantifying and monitoring habitability, (3) human-system design considerations, (4) communications and information management, and (5) training strategies and performance assessments.

The Space Human Factors Laboratory (SHFL) at Johnson Space Center supports applied human factors activities for Space Shuttle, ISS and future flight missions and conducts research funded through the NASA Research Announcements process. It consists of facilities for usability testing, human modeling, anthropometric and biomechanical analysis, and lighting evaluations. These facilities have access to simulated analog environments, such as NASA's Reduced gravity aircraft, as well as means of conducting assessments on board Space Shuttle.

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Human Modeling in Virtual Environments — The objective of virtual environment research at the Graphics Research and Analysis Facility is to develop a computer software system for use in the design and evaluation of complex space structures. Its special features include an immersive user interface, which will allow the graphics model of a structure to be perceived as a virtual environment; and the incorporation of anthropometrically correct graphics models of humans, which can be used to investigate human factors issues such as reachability, fit, and visibility in the virtual environment. By allowing a designed structure to be seen and evaluated "from the inside" at the beginning of the design cycle, long before it is feasible to build a mockup of the structure, the system will lead to earlier recognition of potential problems and make it easier to evaluate alternate designs, resulting in considerable savings in time and funds.

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Research on Computer Biomechanical Modeling — One of the goals in human modeling at the Graphics Research and Analysis Facility (GRAF) is to create a task-oriented human figure model which emulates the physical characteristics of the actual human counterpart as closely as possible. Currently, GRAF's human model is used to solve problems and make predictions related to anthropometry and kinematics. Our overall goal is to extend the current strength model with a systematic and comprehensive assessment of strength for all major joints of the human, and to build a task-oriented modeling system with the astronaut characterized in terms of his/her strength/fatigue and reach limitations. The research requires that a biomechanical modeling system be built which incorporates dynamics, human strength, stamina, range of motion, workload, and fatigue. This model should extend human factors support to operational areas and emphasize the improvement of processes and products.

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Neurosciences — This laboratory, which functions under the auspices of the Life Sciences Research Laboratories, is engaged in a wide-ranging program of ground-based and space flight studies to investigate the effects of unique space flight environmental variables, particularly microgravity, on man's nervous system. As a result of data obtained from the Apollo, Skylab, Shuttle, and Mir missions, attention is being given to studies that attempt to elucidate those neurosensory, sensorimotor, and related physiological mechanisms underlying space-adaptation (space motion-sickness, spatial orientation, and perceptual processes) syndrome and readaptation to Earth. Included are investigations of semicircular-canal and otolith-organ interaction processes, vestibulospinal reflex responses, visual-vestibular interaction processes, vestibular-autonomic interaction processes, eye-hand coordination, and psychophysiological responses to stressful, gravitoinertial stimuli, and postural and locomotion control processes.

The primary focus is operational research directed toward developing reliable predictive techniques and effective countermeasures for space motion sickness, "Earth sickness", and neurosensory, and sensorimotor disturbances during and after flight. Research on countermeasures centers primarily on visual and vestibular adaptation training, centrifugation, and evaluations of new pharmaceuticals for motion sickness and orthostatic intolerance. Another major focus of the laboratory is the effects of extended duration flight on visual/vestibular function, autonomic function, posture, gait, and other sensory systems. In addition, the development of countermeasures to ensure the safe return and egress of flight crews is an area of critical concern. Work is under way to develop new and improved vestibular-response measurement analysis and modeling techniques. Laboratory facilities have recently undergone considerable expansion to accommodate increased efforts to investigate etiological factors and autonomic nervous system responses underlying both motion sickness and orthostatic tolerance. Extensive laboratory instrumentation is available for the generation and control of stimuli and the recording and analysis of a variety of responses.

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Exercise Physiology — One objective is to refine currently available procedures for the measurement of very small changes in bone and muscle mass. Four major physical-measurement systems are being studied: single-axis gamma-ray absorptiometry, x-ray computed tomography, nuclear magnetic resonance, and low-level radioactive counting of activated calcium. Additional indices of acute change are identified through collaborative programs in endocrinology and biochemistry.

The major emphasis is directed toward the quantification of bone mineral by computer tomography and selective rectilinear scanning techniques (oscalsis and lumbar spine). Trabecular bone shows changes in mineralization much faster than cortical bone. Selective rectilinear scanning has now been developed to determine the mineral distribution in a bone section based on measurements of the transmission of gamma rays from an isotope source using a precision scanning instrument. Whole-body x-ray CT scanning of the spine to determine density is now available. One aspect of the research effort will be to miniaturize the scanning instrument and computer for use on a space station.

Magnetic resonance imaging is being used regularly to document the atrophy of the leg muscles in individuals exposed to microgravity and bed-rest simulations of microgravity. Advance-imaging techniques have been developed and are being used routinely. Measurements of changes in water content of the muscles of posture and ambulation are being made before and after periods of bed rest. High-energy phosphates are being measured in vivo and the changes in bone marrow content after bed rest are being followed. Computer enhancement of the images is under way using methods developed for Earth-observation satellites. NASA has available three different magnetic-imaging machines for use in advanced studies of muscle change.

The objectives of this research are to refine current methods of measuring biochemical factors that influence the musculoskeletal system and to correlate these factors with musculoskeletal changes during bed rest and space flight with and without countermeasures. Specific subtasks include (1) quantifying biomechanical loads during exercise using methods that require minimal operating space in flight, (2) automating signal acquisition and processing methods, (3) performing stress analysis on the skeleton for the exercises measured using finite element analysis, (4) measuring musculoskeletal changes during bed rest and space flight, (5) refining techniques to measure changes in trabecular architecture and material properties using acoustic or magnetic resonance imaging methods, and (6) correlating these changes with the exercises and stresses during exercise countermeasures.

The goal of the exercise countermeasure program is to maintain crew members' neuromuscular capability, systemic aerobic and anaerobic performance, skeletal muscle function, and bone integrity during space flight missions.

Laboratories supporting this research contain comprehensive facilities in the areas of biomechanics, exercise physiology, neuromuscular, and hardware development. In addition, the design and development of space flight exercise equipment is a fundamental aspect of the exercise countermeasure program for both the space shuttle and space station.

Operational and ground-based research is conducted. Operational research takes place during space flight missions, while ground-based research is performed in (1) laboratory settings, (2) underwater-thus attaining neutral buoyancy in the Neutral Buoyancy Laboratory, and (3) on board NASA's KC 135 aircraft, where short duration zero gravity is achieved by flying parabolic maneuvers.

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Microgravity Associated Skeletal Muscle Atrophy — Human space explorers undergo a variety of physiologic adaptations to the microgravity environment to which they are subjected during space flight. In both astronauts and cosmonauts, atrophy of skeletal muscle with a concomitant reduction in functional capacity when returning to the normal terrestrial gravitational environment has been documented. Reductions in calf circumference, development of negative nitrogen balance, increased urinary excretion of muscle protein-derived amino acids, decrements in strength and force-velocity relationships in selected muscles, and loss of muscle volume as verified by magnetic resonance imaging have all demonstrated muscle atrophy is a consequence of space flight. A variety of studies in astronauts/cosmonauts, human test subjects under conditions of simulated microgravity (bed rest and/or limb suspension), and in hypokinesia/hypodynamia animal models are in progress to elucidate the mechanism of microgravity associated muscle atrophy in order to devise, implement, and test the efficacy of countermeasures to prevent or attenuate its occurrence. The following approaches are proposed for future studies: (1) histochemical and histomorphometric evaluation of muscle biopsies from flight crew members, bed rest test subjects, or animal models; (2) quantitative image analysis of magnetic resonance images from muscles suspected of being susceptible to atrophy; (3) development and study of in vitro (tissue culture) models of muscle atrophy; (4) analysis of possible muscle atrophy markers; (5) study of structure/function relationships of muscle mitochondria and capillaries; and (6) development and testing of countermeasures. Techniques used in these studies will include muscle enzyme and lectin histochemistry, monoclonal immunohistochemistry, and morphometric analysis by digital planimetry; diagnostic medical imaging and quantitative image analysis; tissue culture and two-dimensional gel electrophoresis; spectrophotometric, spectrofluorimetric, and turbidimetric biochemical assays; in situ hybridization; and subcellular fractionation.

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Cardiovascular Research — For the most part, cardiovascular responses to weightlessness seem to be appropriate for the space flight environment. However, these responses leave astronauts ill-prepared for their return to Earth, when they have reduced circulating blood volume, reduced exercise capacity, and decreased orthostatic tolerance. Recent evidence has suggested that autonomic regulation of the cardiovascular system is a major contributor to the problems experienced on landing day. Every autonomic response that has been measured before and after flight has been different from that of preflight or landing day. The tests include Valsalva maneuvers, stand tests, baroreflex function, beat-to-beat heart rate and arterial pressure dynamics, responses to lower body negative pressure, and catecholamine responses to orthostatic stress.

We are using the above tests and others to study the mechanisms of the cardiovascular changes associated with space flight and to develop appropriate countermeasures. The research environments include space flight, parabolic flight, centrifuge facilities, and bed-rest studies. Work is performed at both JSC and nearby medical centers.

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Cardiovascular Responses to Exercise — Aerobic exercise capacity is decreased after bed rest or space flight. This decease is potentiated in the upright compared to the supine position, suggesting that at least part of the decrement is related to an orthostatic component. Research is in progress to study the mechanisms responsible for the declines in aerobic and anaerobic exercise capacities after space flight.

A decline in aerobic exercise capacity could result in greater fatigue during long duration work tasks such as building a space station, and could limit the ability to perform high-intensity exercise countermeasures. Research focuses on identifying an effective exercise countermeasure prescription to maintain exercise capacity through an efficient combination of aerobic and resistive exercises. We also study combining exercise with exposure to lower body negative pressure as a method of improving the effectiveness of aerobic exercise in maintaining muscle and bone mass, and aerobic and anaerobic capacity.

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Space Food Development - The Space Food Systems Laboratory supports food development activities for the Shuttle, International Space Station, and future missions. Advanced planetary missions require major efforts in food development especially in packaging and process engineering. Research areas of interest include: food development, food processing, food equipment engineering, acceptability measures for microgravity and isolation, food bioregeneration, shelf life extension up to 5 years, preservation, packaging, and food waste management.

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SPACE SCIENCES

Space Plasma Environment – **Kinetic and Fluid Modeling** — This research area is related to understanding the space plasma environment and its effects on human space flight, particularly in the area of radiation health. The space plasma environment contains all the particles and fields that affect space missions in earth orbit, as well as in interplanetary travel. This environment includes the radiation belts, the magnetosphere and the solar wind. Modeling plasma processes on or near the sun is also of interest, since solar activity is one of the principal sources affecting the space plasma environment (the other primary source being cosmic rays). Modeling involves using analytical methods and numerical techniques to study either the kinetic or fluid properties of the space plasma, with the goal of ultimately producing results applicable to reducing radiation risk during space missions. Anyone interested in this opportunity is welcome to contact me directly for further discussion.

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Orbital Debris Hazard Assessment — NASA Johnson Space Center has a program to better understand the character of the man-made orbital debris environment, the implications of this environment on the design and operations of spacecraft, and the development of national and international standards to minimize the future orbital debris environment.

This program consists of four major components: (1) modeling of the environment; (2) measurements of the environment; (3) hypervelocity impact testing to determine the consequences of the environment and the design of shielding; and (4) consulting with industry, other government agencies, and other space-faring nations for making cost-effective recommendations to minimize the hazard to future spacecraft.

Predictions of the flux resulting from the orbital debris environment are made from both source and sink models, which include spacecraft traffic models, satellite breakup models, and atmospheric drag models. We test these predictions against environmental measurements. Such measurements include the relatively large (>10 cm) objects maintained in the US Space Command catalog, intermediate sized (1 mm to 10 cm) that are sampled by ground telescopes and high-frequency ground radars, and small objects (<1 mm) that are sampled through hypervelocity impacts on recovered spacecraft surfaces. JSC obtains data using a three-meter liquid mirror telescope and the Haystack radar, maintains samples from several recovered satellite surfaces, and maintains laboratories to measure the characteristics and chemistry of impact craters. To date, the measurements program has identified sources of orbital debris that were not included in the models.

The probability that a spacecraft will fail to function because of an orbital debris or meteoroid impact can be reduced with specially designed shielding. JSC maintains three hypervelocity guns, and has played a critical role in designing shields for the planned Space Station. In an effort to minimize the shielding weight of the Shuttle and Space Station, hypervelocity (velocities greater than 5 km/sec) tests are conducted on various spacecraft materials and configurations.

JSC has prepared a NASA safety standard, which includes guidelines and procedures for limiting orbital debris. We also conduct regular meetings with other US agencies and the "Inter-Agency Space Debris Coordination Committee" (with members from the US, Europe, Russia, and Japan). The purpose of these meetings is to coordinate research and reach a common consensus for the international standards of limiting orbital debris.

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Planetary Materials Analysis and Process Simulation - One very important approach to deciphering geologic history is through experimental simulation of the processes involved in basalt generation and crystallization. Towards this end, we subject basaltic melts to temperatures and pressures that they might have experienced on their parent bodies and compare the resulting synthetic basalts with natural lunar samples or basaltic meteorites. Emphasis has been placed on minerals and liquid compositions believed to have played an important role in the geochemical evolution of the lunar crust and mantle, in petrogenesis of Martian meteorites, and in the petrogenesis of the very primitive angrite meteorites. However, studies of other compositional systems having relevance to planetary science are also encouraged. Equipment includes one-atmosphere, gas-mixing furnaces capable of reaching 1,500oC, internally and externally heated pressure vessels covering conditions to 10 kbars and 1,200oC, a piston-cylinder apparatus covering conditions to 40 kbars, and a multi-anvil device that operates routinely at 50-100 kbars and is capable of reaching 200 kbars. Modern electron microprobe and electron microscope facilities are also available.

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Chondrule formation processes: The identification of chondrule precursors in unequilibrated chondrites and the partial melting of these precursors to form porphyritic chondrules is an important new area of interest. Recent studies have shown that partial melting of chondrule precursors to form porphyritic chondrules is more common than previously thought. I have started an extensive experimental study of the kinetics of partial melting of chondrule precursor like material with the intent of placing new constraints on the formation process. The student researcher would participate in this study in two ways. 1) Conducting experiments to determine the nature of the partial melting process with emphasis on the rate of destruction of relict materials during the heating event and the overall time constraints that can be placed on the duration of the chondrule forming event. 2) Examination of thin sections from the meteorite collection to find examples of relict materials in chondrules or precursor aggregates and porphyritic chondrules formed by partial melting for comparison with the experimentally produced products. It is important to determine what kinds of relict material are most common and what kinds of contrasting textures exist between these materials. Ultimately we would like to establish criteria to determine what is relict and what is not and what aggregates are possible chondrule precursors. Mineral fragments of widely disparate composition and physical appearance are readily identified, but how do we determine whether minerals similar those in the chondrule are relict? How might partial melting textures on whole chondrules be identified when the chondrule is not incorporated into another chondrule, but was simply slightly melted and cooled a second time. All these questions lead to an increased understanding of the complexity of the chondrule-forming event.

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Soil Chemistry and Mineralogy — A research program is underway to develop synthetic, inorganic highly reactive “soils” for plant growth experiments in microgravity. One particular system, “zeoponics,” is the cultivation of plants in zeolite substrates that contain essential plant-growth cations on their exchange sites and have minor amounts of mineral phases (e.g., synthetic apatite) supplying essential plant growth anions. The exchange behavior (i.e., ion-exchange selectivities, kinetics of exchange) of zeoponics systems is being examined. In addition, plant growth experiments have been conducted to determine economics of plant production in zeoponics systems compared with other plant growth systems (e.g., hydroponics).

Other projects in soil chemistry and mineralogy are encouraged, especially clay mineralogy, zeolite chemistry and mineralogy, and mineral syntheses. Several studies are underway to determine the possible mineralogy and chemistry of Martian surface materials and the mineralogy of phyllosilicates in meteorites and interplanetary dust particles. Experimental and analytical facilities include x-ray diffraction, infrared spectroscopy, electron microscopy (e.g., scanning transmission electron microscopy, scanning electron microscopy, and electron microprobe), and atomic absorption spectroscopy.

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Experimental Trace-Element Partitioning and Petrogenesis of Extraterrestrial Igneous Rocks - One very important approach to deciphering geologic history is through the study of trace-element abundances in rocks. Reliable interpretation of such abundance data requires knowledge of the effects of geological processes on trace-element abundances. In order to contribute to this knowledge, we are studying the partitioning of various trace elements between silicate melts and several geologically important minerals in controlled laboratory experiments. Effects of mineral and melt composition are being systematically investigated. Emphasis has been placed on minerals and liquid compositions believed to have played an important role in the geochemical evolution of the lunar crust and mantle, in petrogenesis of Martian meteorites, and in the petrogenesis of the very primitive angrite meteorites. However, studies of other compositional systems having relevance to planetary science are also encouraged. Equipment includes one-atmosphere, gas-mixing furnaces capable of reaching 1,500oC, internally and externally heated pressure vessels covering conditions to 10 kbars and 1,200oC, a piston-cylinder apparatus covering conditions to 40 kbars, and a multi-anvil device that operates routinely at 50-100 kbars and is capable of reaching 200 kbars. Modern electron microprobe and electron microscope facilities are also available.

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Investigations of Natural and Experimental Hypervelocity Impacts — We pursue hypervelocity meteorite impact as a geological process to learn about the accretion, differentiation, and the evolution of current, heavily cratered surfaces of planets and their moons, including the collisional evolution of small solar system objects. Our largely experimental approach uses powder propellant and light gas gun facilities to launch a variety of projectiles into geologic solids at velocities as high as 7 km/s. Postmortem analysis of these laboratory impacts may range from cratering mechanics to the shock-induced modifications of minerals and rocks. These experimental studies are partially complemented by the analysis of naturally shocked materials, field studies of terrestrial impact structures, and theoretical considerations. We are interested in the velocity distribution of crater ejecta and collisional fragmentation products, the evolution of asteroidal regoliths and meteoritic breccias, and the shock metamorphism of carbonates. Additional efforts focus on the development of aerogel as a suitable capture medium for hypervelocity projectiles in support of STARDUST, a Discovery-Class comet fly-by mission. Such capture media are also being exposed on the MIR Station to trap both natural cosmic dust and man-made orbital debris; these collectors were retrieved in September 1997 for post-flight analysis.

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Physicochemical State of the Martian Surface — The general objective of this continuing research program is to understand the nature and constitution of surficial material on Mars and to determine the weathering processes that evolved the surface to its current state. Specific tasks include (1) studies of geologic samples that have been weathered in terrestrial environments considered to be analogous in some important respects to those on Mars, (2) theoretical and experimental studies of the optical properties of pure and substituted iron-bearing compounds, and (3) instrument development. Emphasis is placed on multidisciplinary analyses of samples to maximize comparison with the database available for Mars from the Viking, Phobos-2, and Mars Pathfinder missions and telescopic observations. Experimental and analytical facilities include ferromagnetic resonance spectroscopy, vibrating sample magnetometer, Mössbauer spectroscopy, and ultraviolet-visible-infrared spectroscopy. Instrument development includes a backscatter Mössbauer spectrometer for planetary applications.

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Analytical Studies of Space Weathering Effects on Lunar and Asteroid Surfaces — A long-term program is underway to analyze and interpret many of the characteristics of lunar soils, cores, and regolith breccias. Lunar soils have formed by complex processes including impacts, solar wind implantation and radiation effects, and volcanic processes that were active in earlier lunar history. Ancient lunar soils are preserved in some regolith breccias and in some of the returned core material. A challenging research task is to decode the record in these ancient regoliths using clues from current ones, and to determine something about the meteorite flux; meteorite composition; solar wind, flare, and early volcanic activity; and general lunar evolution over the course of lunar geologic history. A major objective is to quantify the physical, chemical, and optical effects of space "weathering" on exposed lunar soils and possible asteroid regolith material (interplanetary dust particles). Research techniques include optical and scanning electron microscopy petrographic analysis; electron microprobe analysis; scanning electron microscopy studies of grain surfaces and textures; transmission electron microscopy studies of textures including radiation and shock damage; quantitative analysis of grain sizes, grain shapes, and surface features; and population studies of mineral and glass phases. Experience in petrology, scanning electron microscope analysis, transmission electron microscope analysis (including high-resolution work), image analysis, and geochemistry would be useful for this project.

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Characterization of Possible Biomarkers in Mars Meteorites —The field of Astrobiology was galvanized by our report in 1996 of possible evidence for life in Mars Meteorites ALH84001. We are currently studying several other Mars meteorites. A total of at least 15 Mars meteorites are known and about half of them are in the Antarctic meteorite collection at JSC. Each of these meteorites should be investigated for possible biomarkers. We are currently using FEGSEM, TEM, electron microprobe for chemical mapping and quantitative analysis, fluorescence microscope imaging for specific organic compounds and TOFSIMS for organic compound detection, characterization, and mapping. We are also developing an immunological assay technique using array technology. This technique will be incorporated into a possible flight instrument to be landed on Mars to search for organics and possible biomarkers in the Martian soil and subsurface as sampled by drills and cores. In addition, we anticipate that the immunological array will be used to help check returned Mars samples for possible biomarkers. We are developing a microbiology laboratory for culturing and studying extremophiles from earth. We are also interested in experimental fossilization studies for microbes and viruses. Students interested in these topics could work directly on Mars meteorites, terrestrial analogs, technique and instrument development for Mars robotic missions, experimental fossilization studies, or culturing and DNA/RNA characterization of appropriate microprobes from various terrestrial environments. Students should have background or interest in any of the following broad topics: biology, geology, astrobiology, Mars planetology, immunology, and instrumental microanalysis.

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Isotopic and Chemical Studies of the Evolution of Solid Objects in the Solar System— Laboratory analyses of lunar, meteoritic, and terrestrial samples are conducted to provide isotopic, chronological, and chemical constraints for the evolution of solid objects in the solar system.

Current emphasis centers on lunar sample and meteorite analysis. Research on related terrestrial evolutionary analogs will also be considered. Facilities include clean laboratories for physical and chemical preparation of samples and two thermal-emission mass spectrometers for sample analysis. One of these is a multisample, seven-collector, late-generation instrument. The laboratory's lunar sample analysis program emphasizes the geochemical evolution of lunar mare basalts and highland rocks as recorded in their isotopic systematics. The meteorite analysis program applies isotopic constraints to the chronology and petrogenesis of basaltic meteorites, the formation of the solar system, and to stellar nucleosynthesis. Research that emphasizes laboratory or theoretical investigations of lunar-basalt genesis, genesis of basaltic rocks on other planetary objects, or categorization and interpretation of nucleosynthetic components in primitive meteorites is especially appropriate for our program. Research that focuses on planetary crustal development also is appropriate, as are studies that seek to unravel the cratering history of planetary surfaces or the history of meteorites in space by measuring cosmic ray-produced nuclides.

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Noble-Gas Isotopic Abundances in Planetary Materials — Isotopic abundance determinations of the noble-gas elements (He, Ne, Ar, Kr, and Xe) in meteorites and lunar samples furnish important information on a variety of planetary problems. Some problems recently addressed by our laboratory include (1) the isotopic composition and origin of various volatile components in the solar system, including the atmospheres of Mars and other planets, solar wind species implanted into the lunar regolith, and ancient energetic solar emissions; (2) the 39Ar-40Ar chronology of the formation and metamorphism of various meteorite types, including Martian meteorites, and of the early lunar crust; and (3) the history of collisional breakup events among meteorite parent bodies and the ages of lunar surface features using noble gases produced by energetic cosmic ray protons and by 39Ar-40Ar dating. Most types of isotopic measurements of noble gases are possible, including those on irradiated samples. Available equipment includes two high-sensitivity noble gas mass spectrometers with computer control, low-blank induction-heated furnaces equipped with thermocouples, an infrared laser equipped with a focusing and imaging system, a gas calibration system, and low-blank vacuum systems.

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Volatiles in Extraterrestrial and Terrestrial Materials — Studies of the abundances, distributions, and isotopic compositions of volatiles in lunar samples, meteorites, interplanetary dust particles, and terrestrial samples provide important information of the past thermal conditions and gaseous environments under which they were formed and have undergone subsequent modifications. Studies of the volatile elements (i.e., H, C, O, N, and S), abundances, and isotopic compositions in extraterrestrial materials help us understand the evolution of volatiles on other bodies in our solar system. Recent investigations have concentrated on the study of meteorites from Mars. Our work has shown the presence of possible biogenic activity within one of the oldest Martian meteorites. Research on the isotopic composition of oxygen (i.e., three isotopes) within components in the Martian meteorites reveals distinct oxygen reservoirs. Carbon isotopic compositions of carbon-bearing components within the Martian meteorites vary by over 100 per mil, suggesting a record of extreme carbon fractionation on Mars. We take isotopic measurements of the volatile elements within samples after we characterize materials with microscopic observations. These combined studies help us decode the unusual record of biogenic activity recorded within the Martian meteorite.

Investigations use the latest analytical equipment, including two stable isotope mass spectrometers, and laser microprobes interfaced to either mass spectrometers or gas chromatographs/computer systems. Other examples consist of (1) microfluorination-laser extraction techniques for the measurement of three isotopes of oxygen within silicate systems; (2) microthermometry for the study of fluid inclusions; and (3) analytical instrumentation to determine the identity of the volatiles released during heating and/or crushing and laser extraction, and to determine abundances, temperature-release ranges, isotopic compositions, and sequence of release. Analytical facilities are also available for the measurements of abundances, distributions, and isotopic compositions of a variety of terrestrial and extraterrestrial materials.

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Space-Radiation Environment — Space-radiation environment is a significant consideration in planning any long-duration mission both in low-Earth orbit and in interplanetary space. To maintain our ability to assess the environment and to minimize the risk to humans in space, an active program entails computer modeling of radiation received by the human body and careful measurements of the radiation environment both outside and inside the space shuttle. Research concerns advanced concepts of dosimetry, including identification of the elemental composition, energy, and direction of incident radiation, as well as real-time calculations and display of radiobiological effectiveness. This currently involves the design and construction of a solid-state charged particle telescope and acquisition of data on the inner radiation belt and galactic cosmic rays (GCR) through its operation on Shuttle flights and Mir flights. Other activities include improvements of GCR models and inner belt models to account for variations caused by the 22-year solar cycle.

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Geochemistry of Lunar Rocks, Achondrites, and Terrestrial Analogs — Lunar highland igneous and metamorphic rocks are products of early lunar differentiation that have been broken and reheated by meteorite impact. Achondritic meteorites are fragments resulting from differentiation and impact on smaller, usually asteroidal parent bodies. Some achondrites are igneous meteorites blasted off the surface of Mars. Terrestrial igneous rocks, both volcanic and plutonic, result from differentiation on the much larger and more complex planet Earth. Studies of the four types of materials may lead to a broader understanding of planetary differentiation. Major and trace-element analyses by neutron activation are coupled with petrologic studies of the planetary fragments and experimental studies of analogs in order to look through these impact processes to the precursor igneous rocks and evaluate planetary differentiation. Studies of terrestrial analogs to lunar and meteoritic igneous rocks are valuable in constraining the processes of igneous differentiation.

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Mineralogy of Fine-Grained Extraterrestrial Materials — The early history of the solar system is being explored through detailed characterization of the minerals and noncrystalline phases composing primitive extraterrestrial materials. As these materials are typically very fine grained, this research is being performed principally by analytical electron microscopy, high-resolution transmission electron microscopy, and x-ray microdiffraction, as complemented by standard petrographic and electron-beam techniques. We are currently examining carbonaceous chondrites, as well as interplanetary dust particles (IDP) collected from the stratosphere and from Greenland and Antarctic Ice. Of particular interest are IDPs with refractory mineralogies, which potentially contain very primitive nebula condensates and/or presolar materials and the record of low-temperature planetary alteration processes, as revealed by the paragenesis of the matrix phases within carbonaceous chondrites. We are also developing particle collectors for the Stardust Discovery Mission to Comet Wilde Z and are characterizing collection surfaces flown on the Long Duration Exposure Facility, Eureca, and Mir.

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Experimental Investigations of Planetary Processes — Experiments delineating the geochemical behaviors of chemical elements during planetary processes are important for understanding the elemental abundance patterns that are observed in planetary materials. Specifically, geochemical behaviors of elements change with temperature (T), pressure (P), oxygen fugacity (f02), and bulk chemical composition of the system (SCi). Laboratory experiments are performed to better understand the detailed geochemical behaviors of trace elements in planetary processes such as core formation and basalt genesis. The results of these studies are then used to understand the origin of meteorites, the Earth, and the Moon. Because the conditions that pertained during laboratory experiments are seldom identical to those occurring in nature, it is also important to have means of extrapolating laboratory results to different (P, T, f02, SCi) conditions. Thus, our research objectives are (1) to determine the geochemical behaviors of elements in the laboratory, (2) to use these experiments and standard thermodynamic techniques to extrapolate from the laboratory to natural systems, and (3) to use the extrapolated experimental data to constrain the nature of planetary processes.

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Surface Compositional Studies of Planets and Asteroids — The surface mineralogical composition of solar-system bodies has been studied by observing the reflected sunlight in the visible- and near-infrared (IR) spectral ranges and in the thermal-IR emissions of longer wavelengths. Changes in the surface material's mineralogic composition appear as variations in the reflectance spectrum. Research in this area will concentrate on studying the surface compositions of the low albedo asteroids. Thermal-IR and ultraviolet-visible telescopic observational data will also be acquired, extending the studies to different spectral regions. Future research will include the study of weak absorption features attributed to Fe^{2+} - Fe^{3+} charge transfers in iron oxides that are present in phyllosilicates, as seen in the narrowband reflectance spectra of primitive asteroids. Planetary surfaces research is supported by an image-processing system, ground-based telescopic data, and imagery obtained from unmanned space probes.

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Planetary Impact Processes - Impact is the only major geological process common to all solid bodies in the Solar System. As a result of this single pervasive mechanism, craters and regoliths are formed on planetary-scale objects, asteroids and satellites are disrupted, and particles are supplied to the interplanetary dust complex. Many aspects of impact cratering and collisional disruption fall within the purview of the Experimental Impact Laboratory.

Although such experiments can be performed with either of the other two guns in the laboratory, cratering and collisional-disruption experiments are primarily conducted with a vertical gun. Projectiles of various compositions ranging between 3 and 20 mm in diameter can be launched at velocities of tens of meters per second to nearly 3 km/s. In addition, target materials can be varied as dictated by experimental objectives; a refrigerated target chamber permits the use of ice and other low-temperature targets.

Recent investigations have included disruption of various rock and ice targets, the physical and chemical evolution of "experimental regoliths", measurement of ejection velocities, disruption and repetitive impact of a chondritic meteorite, and the chemistry and petrography of agglutinate-like particles created during the regolith-evolution experiments. Theoretical and observational studies of these processes are encouraged.

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Trace Element Analyses of Submicrogram Samples by Ultrahigh Sensitivity Instrumental Neutron Activation Analysis — Many problems in trace element geochemistry have not yet been pursued because available analytical techniques cannot provide sufficiently precise data on small enough samples. We have extended instrumental neutron activation analysis techniques to allow precise analysis of small particles. Overall increases in sensitivity are approximately a factor of a million, so that samples weighing from a few nanograms to a few micrograms can be analyzed for up to 25 elements. The techniques involve irradiations in a high-flux nuclear reactor, followed by gamma-ray counting that utilizes large, low-background germanium detectors in the Radiation Counting Laboratory — an excellent, low-background, underground counting facility. In addition, techniques are continually being improved to interpret the trace element abundance data. These techniques depend on analyzing enough samples to evaluate grain-to-grain heterogeneity, and on understanding the detailed mineralogy of the samples. Because the analyses are nondestructive, subsequent mineralogical analysis can be done by electron microscopy. Alternatively, use of a new micro-coring device allows us to remove samples from previously studied petrographic thin sections. Samples analyzed have been mainly interplanetary dust particles (commonly called "cosmic dust") collected by high-flying aircraft, and various clasts and minerals in a variety of lunar and meteoritic breccias.

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Space Radiation and Biological Systems — Applicants should be interested in performing theoretical
modeling of the effects of space radiation on biological systems. Emphasis is placed on the relationship of the track structure of heavy particles (protons, alpha particles, and heavy ions) to DNA damage and resulting biological responses such as mutation and signal transduction. One of our goals is to develop theoretical models that can describe molecular biology experiments performed to study heavy particle effects. Nuclear reactions in spacecraft shielding and tissue modify the composition of the primary radiation fields including the production of new particle types. The importance of nuclear reactions in risk assessment include the role of shielding material type on reaction rates and the high-energy deposition events that would occur in tissue near reaction sites. An additional goal is to develop biological response models that describe nuclear reactions, track structure, and molecular interactions that will be able to guide the design of optimal shielding materials for radiation protection. Interested applicants should have a background in radiation physics and track structure models, as well as a basic knowledge of molecular biology.

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Remote Sensing and modeling of Biomass Burning NASA JSC research on mapping global biomass burning was initiated in 1990 and has yielded significant results. The imagery from Space Shuttle and the International Space Station cameras and other unmanned satellites is used to model the biomass burning processes and investigate their implications for atmospheric processes. The detection of fires, aerosols and their behavior in an ecosystem context is a major focus of this research.

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Earth Observations Database: The NASA Space Shuttle Earth Observations Database is a valuable source of data for research of Earth’s recent environmental history, and thus for assessment of the human impact on global Earth processes. This data source, although having the longest length on record of any space derived global change database, has not been fully exploited by scientists studying the global changes. The database contains over 400,000 images of earth with global sites some of which have been repeatedly photographed (e.g., Lake Chad In Africa; Aral sea in Kazakhstan). The focus is to develop change detection profiles using these datasets.

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MISSION OPERATIONS

Advanced Operations Technologies — Self-sustained long duration human operations in deep space and support of multiple-vehicle operations will require a revolution in ground and on-board operational techniques. This revolution has to be supported by the development of new innovative/enabling operational tools to be both cost effective and safe. Focus will be placed on vehicle and ground systems technology developments that will require minimal human operational intervention in use. This will drive operations costs down and should improve safety. Operational support capabilities based on cutting edge information systems technologies will be required to enable the reduction in real-time round the clock ground support and training (operations costs) and/or reduce flight crew required attention to maintenance, monitoring, training, and planning (more time for science). Enabling tools are envisioned to be those which utilize advanced computational techniques such as agent-based systems, natural language programming, automatic code generation, validation and verification, and advanced simulation and modeling. Automation tools based on intelligent systems such as expert systems, intelligent search, adaptive reasoning, model- and case- based reasoning, intelligent estimation and diagnostics, need to be develop for applications such as autonomous navigation and flight dynamics tools, automated planning and scheduling, and intelligent operations assistants for automated fault detection/recovery/control. Research is needed on advanced human-machine interfaces such as virtual modeling and visualization, data immersion, telepresence, video teleconferencing technologies, voice recognition/synthetic speech applications to command and control. Research is also needed to enable development of advanced systems for mission data handling such as video compression technologies, automated link management systems, automated data collection/reduction/distribution agents, high capacity/secure networks for data, voice and video.

James N. Ortiz	(281) 483-0520	james.n.ortiz1@jsc.nasa.gov

Command and Control Systems Networks — Research opportunities exist for the following areas of interest: Utilization of high speed switching networks, such as ATM, in support of command and control systems for multiple critical space mission operations. Routing and processing of multiple data types (voice, video, data) and performing commanding in real-time critical conditions.

Patricia Carreon	(281) 483-7052	patricia.carreon@jsc.nasa.gov

Command and Control Systems Real-time Vehicle Processing — Research opportunities exist for the utilization of commercial off the shelf software (Windows NT) in performing real-time analysis of data (1000 plus samples per second) in support of mission critical operations.

Steven A. Gonzalez	(281) 483-6314	steven.a.gonzales@jsc.nasa.gov

Integrated Space Vehicle and Ground System Network — Research opportunities exist for the following areas of interest: Developing methodologies and systems that allow for wide area communications, even across satellites and deep space, that look transparent to the end user. This research would have to take into account signal degradation, latency, and loss of signal while maintaining consistent and reliable information and data exchange for critical mission support.

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Platform Independent Software Components for the Exploration of Space (PISCES)— Research opportunities exist for the following areas of interest: Assist in the design and development of reusable and extendable mission design and analysis algorithms supporting future human missions beyond low earth orbit. Participate in the development of object-oriented web-based software components using a collaborative effort between JSC and universities to demonstrate state-of-the-art distributed programming and mission design and analysis. In particular algorithmic development is focused on providing trajectory and subsystem-related components in JAVA for detailed mission analysis involving returning to the Moon and future human missions to Mars.

Don J. Pearson	(281) 483-8052	don.j.pearson@jsc.nasa.gov

Virtual Reality interface for Space Exploration Missions — Research opportunities exist for the following areas of interest: Developing Virtual reality interfaces into the command and control systems of exploration vehicles for command, control and status of mission systems. This research would look at alternate methods of crew interaction with the exploration vehicles that will not require them to be tethered to a computer display. Research opportunities also exist for Virtual communication between the exploration crew and the community on earth.

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Data Archive for Space Exploration Missions — Research opportunities exist for the following areas of interest: Developing alternate archiving methodologies and systems to accommodate archive of data on the order of quintillion bytes. The methodologies should include information storage instead of data storage; integrated voice, video and data storage and retrieval; distributed and integrated interplanetary storage.

W. Allen Wylie	(281) 483-4738	william.a.wylie@jsc.nasa.gov

Control Theory Application to Management Principles — Apply control loop theory and methods (typically used in mechanical engineering and aerospace engineering applications) to quantify management principles. For example, investigate the hypothesis that if projects are attempted with too much lag between the time a change is needed (e.g., purchase hardware/software or change personnel) and the time that the change is made, the system (i.e., the project) will go unstable and "crash" — just like a control loop for an aircraft will go unstable if too much lag is introduced in the system.

Danny Deger	(281) 483-1997	ddeger@jsc.nasa.gov	Operation Technology

Advanced Training Technologies — Proposals are sought that advance the state of the art in technologies that support training of NASA astronauts and ground based personnel, including simulations. NASA has a special interest in technologies that will reduce the cost and/or enhance the effectiveness of training and training development. In addition to training, proposals are also sought which could lead to the development of intelligent applications for retrieval, management and understanding of text and other Internet and/or intranet information. Proposals are strongly encouraged that demonstrate a high probability of dual use in industry and/or education for the developed technologies.

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SAFETY, RELIABILITY, AND QUALITY ASSURANCE

Risk Management — Opportunities exist for research in areas related to reliability and safety of space vehicles. Multivariate models, such as logistic regression and proportional hazards models, and system reliability models that make use of dependencies between component failure events are specific topics of interest in statistical reliability. Probabilistic fatigue and other physics of failure modeling, which may include simulation studies using finite element models, are safety topics of interest.

Richard P. Heydorn	(281) 483-3227	richard.p.heydorn1@jsc.nasa.gov

Micro/Nano Technologies Reliability and Quality Control — To develop an evaluation capability required to achieve the confidence levels necessary to assure successful verification and validation process of micro/nanotechnologies particularly the MEMS (MicroElectroMechanical Systems). Understanding of failure mechanisms and new quantitative analysis approaches need to be developed for evaluating the reliability and maintainability of these micro scaled devices and sensors.

Examples of the types of new approaches required for the reliability and quality assurance include quantifying the behavior of materials used for the micro/nano scaled devices, determining the failure mechanisms and the probability of failure of these devices while taking into account the added redundancy that is possible because of the low weight, low power, and inexpensive nature of these devices.

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Nanostructured Materials Quality Assurance — Innovative methods of investigating nanostructured materials are requested. With the recent developments being made in developing materials systems based on nanometer size features (particles, grain-size, physical phenomenon, including fullerenes and nanotubes, etc.) a need exists to acquire new methods of investigating this new class of materials as to properties, reliability, and process quality assurance. Diagnostic methods of isolating nanophase conditions are sought, particularly which can be integrated into manufacturing and service conditions for routine assessments.

Alice Lee	(281) 483-5234	alee@ems.jsc.nasa.gov

Nanotube Safety Study — Biological and toxicity study on the effects of carbon nanotubes on humans. Proposals are sought that study the effects of nanotube exposure to humans from handling and inhalation that might be the result of airborne particles and other direct contact methods.

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Wireless System Safety Risk and Risk Mitigation — Wireless system is used for data transmissions from critical sensors such as strain gauges, thermometers, and accelerometers on spacecraft. Risk and risk mitigation of the wireless system become more important as the design for long duration deep space flights become more complicated. It is urgently needed to investigate the following risks and risk mitigation of wireless systems on board a spacecraft: noise from space; interference from other wireless system such as communication systems to and from ground; interference from transceiver nodes in the same WS; in case of accidental meteoroid hits; failure due to changes in the component characteristics such as receiver sensitivity change and frequency stability change in the synthesizer; critical data loss due to the malfunction of the WS components.

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MEMS COTS Parts Qualification and Certification Criteria — This task is (1) to establish Qualification and Certification criteria to be used in assisting spacecraft developers in the selection of radiation tolerant microelectronics parts for human mission insertion, (2) to define the resolution of MEMS radiation hardness assurance problems, and (3) to develop MEMS COTS parts qualification and certification criteria for the future spacecraft system design readiness reviews.

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MEMS Device Pre/Post Processing Characterization — In order to understand the problems involving a variety of applied loading conditions of a MEMS device, including externally applied static forces, pressures and temperatures, the inner working of the MEMS devices must be fully characterized to predict temperature, stresses, and dynamic response and possible failure mechanisms. Finite Element Analyses in various cases have been effectively applied to assist in the design reliability.

This task will perform various Finite Element Analyses such as heat transfer analysis, thermal stress analysis, thermal fatigue stress analysis, static analysis, and model analysis of the selected device for design reliability characterization.

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Develop Packaging Process Guidelines for MEMS and ASIM — Since MEMS can interact with the environment through mechanical and fluid forces, the traditional EEE parts packaging process can no longer assure the desired quality. Packaging should include integration of MEMS with electronics on a single substrate, interconnection of circuits in a multichip module, interfaces with the macroscopic parts, and meet space environment requirements.

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Develop Spacecraft System Interface Requirements for Micro and Macro Hybrid Systems — To develop interface requirements for hybrid systems that integrate micro scaled devices such as MEMS (MicroElectroMechanical System) and ASIM (Application Specific Integrated Micro-instruments) to the existing traditional macro scaled spacecraft systems. Interface requirements include: electrical, optical, thermal, fluid, and mechanical specifications for interconnects and packaging.

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MEMS COTS and ASIM Devices System Insertion Risk Assessment — This task identifies existing candidates for MEMS (MicroElectroMechanical System) and ASIM (Application Specific Integrated Micro-instruments) devices insertion to the spacecraft for either upgrade or replacement to the existing macro scaled parts. The candidates to be replaced by MEMS are the devices that are heavy, in large size, and consume high power. This task will study the system insertion architecture of selected system(s) to identify integration interface risks of the hybrid system (contains both micro and macro devices). Risk mitigation methods will also be identified.

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KENNEDY SPACE CENTER

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Mission

The Kennedy Space Center (KSC) is designated as the Center of Excellence for Launch and Payload Processing Systems. Kennedy Space Center's mission includes Space Launch Operations and Spaceport and Range Technologies.
Kennedy Space Center is NASA' s primary launch site. Kennedy Space Center is responsible for assuring that sound, safe, and efficient practices and processes are in place for private/commercial processing. Kennedy Space Center personnel contribute operational expertise to increase the use or operational knowledge in the design and development of payloads and launch vehicles; KSC partners with a wide range of entities to develop new technologies for future space initiatives. Additionally, Kennedy Space Center personnel continually enhance core capabilities to meet customer needs. Kennedy Space Center's focus is shifting from operations to research and development and will cumulate in transition to a Spaceport Technology Center.

The Kennedy Space Center has five key Spaceport Technology and Science Development Initiatives.

1. Fluid System Technologies. This area involves technologies to connect and automate umbilicals. It involves several cryogenic-related topics including thermal insulation systems, advanced components, advanced techniques in the loading, storage and transfer of cryogenics, and other low-temperature applications. It also involves alternate fluids and in situ propellant production.
2. Spaceport Structures and Materials. Technology related to launch structure or mechanisms is a part of this initiative. Material fatigue and fracture issues are also involved. Material science and technology are also an important component. Corrosion science and technology, electromagnetic physics and nondestructive test evaluation are also key areas of interest.
3. Process Engineering. This area includes human factors, work methods and their measurement and risk assessment. It also involves process or operations modeling and analysis; systems modeling or analysis; and scheduling or capacity analysis.
4. Command, Control, Monitoring & Range Technology. This area involves self-monitoring systems, sensors and instrumentation. Autonomous or intelligent technologies are also involved. Weather modeling and prediction are included. Space traffic control and space-based range systems are also important areas of interest.

5. Plant and Microbiological Science. This area involves Bioregenerative advanced life support systems and ecological monitoring. There is also an opportunity for life science experiments and payload development. Study in molecular biology is also included.

KSC also has an interest in research related to spaceport design and systems development. Five broad areas have been identified:

1. Launch and launch vehicle processing systems
2. Payload and payload carrier processing systems
3. Landing and recovery systems
4. Range systems
5. Extra-terrestrial spaceport support systems

More on all these research areas can be found at: http://www.pao.ksc.nasa.gov/kscpao/spacetech/, or call the program administrator.

LANGLEY RESEARCH CENTER

Program Administrators	
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Mission

The mission of the NASA Langley Research Center is to increase the knowledge and capability of the United States in a full range of aeronautics disciplines and in selected space disciplines. The following information provides, by Competency, an overview of the current disciplines in the Langley program. Specific research activities associated with each discipline are also included.

Aerospace Systems, Concepts, and Analysis Competency — The Aerospace Systems, Concepts, and Analysis (ASCA) Competency purpose is to develop and deliver advanced concepts and systems analyses results that enable program offices to meet program objectives and that enable the Agency to develop future aerospace technologies. Areas of expertise include aerospace advanced concepts development, aerospace enterprise goal achievement and benefits assessment, and independent assessment of aerospace concepts. Areas of research include advanced aerospace vehicle concepts, multidisciplinary analysis methods and tools, high performance computational test beds, independent assessments, planetary entry systems, concepts of planetary aircraft and the International Space Station.

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Vehicle Analysis and Planetary Exploration Branch — The Vehicle Analysis Branch enhances the Aerospace Systems, Concepts and Analysis Core Competency effort by developing advanced aerospace concepts to meet Agency and National space transportation goals. VAB conducts conceptual analysis of launch vehicle concepts, hypersonic airbreathing systems, in-space transportation systems, and planetary entry systems. It provides technical expertise in the following areas: systems analyses of new and existing aerospace vehicle concepts to improve systems performance, reliability, safety and reduce cost; technology assessments and evaluations to aid in hypersonic and space transportation technology program planning and implementation; aerodynamics and performance database development for near-term flight systems; assessments and improvements to planetary entry flight systems and human exploration of space development activities. VAB provides systems analyses and independent evaluations to the NASA Independent Program Assessment Office and maintains and develops analytical expertise and analytical tools to support the systems analyses activities.

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Spacecraft and Sensors Branch (SSB) — The Spacecraft and Sensors Branch (SSB) enhances the ASCA Competency effort by conducting Phase A designs of spacecraft, instruments and experiments. The Branch performs analysis of mission concepts for the International Space Station (ISS), human space exploration, as well as space missions that do not require crew participation. SSB provides technical expertise in the following areas: definition and conduct of engineering studies and technology trades, analysis of spacecraft subsystem performance and interfaces; assessment of critical issues; independent evaluation of flight and ground systems performance; and system requirements analysis. The Branch develops and maintains the LaRC Collaborative Engineering Center (CEC) and provides expertise relative to the development of the NASA Intelligent Synthesis Environment (ISE) program. SSB develops electro-optical/microwave instrument concepts consistent with mission requirements. SSB conducts research on the utilization of GPS reflective signals to determine sea/surface state as well as land surface features. SSB conducts analytical studies of space experiments and accommodations for these experiments.

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Systems Analysis Branch (SAB) — The Systems Analysis Branch (SAB) conducts multidisciplinary studies and analyses of advanced vehicles and the integrated air traffic system. The goals of the Branch are:

- Identify high-potential future concepts
- Provide analyses in support of major research programs and program planning
- Provide assessment of Aero-Space Technology Enterprise Three-Pillar Goals
- Develop and disseminate advanced system analysis methods and databases

Disciplinary expertise for conceptual studies includes the following areas:

- Aerodynamics/stability and control
- Propulsion and noise
- Performance and sizing
- Configuration integration and subsystems
- Weights/structures and aeroelastic analysis
- Aviation safety
- Cost/risk/airspace system and global benefits

Samuel M. Dollyhigh	(757) 864-6503	s.m.dollyhigh@larc.nasa.gov

Advanced Aircraft Branch (AAB) — Advanced Aircraft Branch (AAB) is responsible for theoretical, experimental, and overall systems studies directed toward advancing the state of the art for survivability of advanced military aircraft. AAB functions as an in-house conceptual design group which integrates the aerodynamic, propulsion, structural, and survivability aspects of high-performance military vehicles. The Branch conducts additional contracted studies to support in-house conceptual design work and serves as an interface and stimulus between basic research and practical applications and performs systems analysis studies of vehicle concepts, specific aircraft, and impact of individual technologies. AAB identifies new research program thrusts and defines system-level benefits and advocacy material.

AAB provides systems analysis support to agency programs by close interaction with Langley Vehicle Thrust Managers, other groups including the Core Competency Groups, NASA Headquarters and other Centers and agencies. AAB assesses progress toward specific program goals with appropriate metrics, identifies potential application of new technology, and encourages interaction between focus groups across competencies at Langley.

William J. Small	(757) 864-5217	w.j.small@larc.nasa.gov

Multidisciplinary Optimization Branch — The Multidisciplinary Optimization Branch conducts basic research in Multidisciplinary Design Optimization (MDO) methods and participates in MDO applications with other NASA researchers and the U.S. industry. The focus is the development, demonstration, and validation of computational MDO techniques and tools for the design and optimization of aerospace vehicles throughout their flight envelope. Specific areas of methods research and applications include: optimization algorithms, system decomposition and mathematical formulations of MDO; computational environments and frameworks for MDO; design-oriented analysis at the system level; parametric geometry modeling and computational gridding; and the extension of MDO to embrace the entire lifecycle of engineering products. A major goal of this effort is the timely transfer of validated technology to the U.S. industry and to NASA researchers.

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Computational AeroSciences Team — The Computational AeroSciences Team manages the Langley High Performance Computing and Communications Program (HPCCP), which includes activity in the Computational AeroSciences (CAS) Project and Learning Technologies Project (LTP). The main CAS focus at Langley is the development of computational tools, visualization tools, databases, user interfaces, and system software to facilitate the multidisciplinary design and optimization of aerospace systems. The Learning Technologies Project increases public access to scientific databases, develops new applications and pilot programs for using science data, and creates new curriculum products and tools for K–14 education.

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Jeffrey M. Seaton	(757) 864-6687	j.m.seaton@larc.nasa.gov	Learning Technologies Project

Airborne Systems Competency — This Competency conducts focused and basic research and technology development programs in flight mechanics, guidance, navigation, control, crew systems, and operating procedures for aircraft and spacecraft. It also develops analytical methods, experimentally evaluates methods and concepts, and serves as the Research and Technology focal point for flight and piloted simulation testing. Opportunities for research exist within areas of electronic and optical technologies for aircraft- and spacecraft-borne systems. Research is aimed at information acquisition, processing, and systems integration for mission- and life-critical aerospace applications. Responsible for conduct of all NASA flight operations and implementation of real-time flight simulations for the Langley Research Center. Assist in the formulation of flight and simulation programs to safely extract research information from flight and/or simulator experiments. Plan, fabricate, and install aircraft experimental modifications and instrumentation. Develop discrete mathematical models of vehicles and their subsystems for pilot in the loop simulations. Provide advocacy and consultation for a robust aviation safety program. Maintain, modify, repair, and ensure airworthiness of all aircraft assigned to the Center. Develop special flight and simulator research techniques to fit the needs of specific aeronautical, electronic, structural, and space research programs. Provide experienced personnel to serve as test aircrews in aeronautical and space simulator and other human factor studies.

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Dana J. Dunham	(757) 864-5061	d.j.dunham@larc.nasa.gov	Vehicle Dynamics
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Thomas G. Campbell	(757) 864-1772	t.g.campbell@larc.nasa.gov	Electromagnetic Technology
Plesent W. Goode, IV	(757) 864-6685	p.w.goode@larc.nasa.gov	Systems Integration
Raymond S. Calloway	(757) 864-6218	r.s.calloway@larc.nasa.gov	Assessment Technology

Tony L. Trexler	(757) 864-3922	t.l.trexler@larc.nasa.gov	Avionics Equipment; Basic Aircraft Tools and Equipment; Aircraft Management Aids; Safety Equipment/Tools; Ground Support, Inspection/Test, and Aircraft Stock/Stores Equipment
Calvin C. Chandler	(757) 864-3900	c.c.chandler@larc.nasa.gov	Basic Aircraft Tools and Equipment; Aircraft Management Aids; Safety Equipment/Tools; Ground Support, Inspection/Test, and Aircraft Stock/Stores Equipment
Artie D. Jessup	(757) 864-3971	a.d.jessup@larc.nasa.gov	Applications Software; Development Hardware; Computers; Electronics Subassemblies; Video/Camera Equipment
Richard B. Bryant, Jr.	(757) 864-7548	r.b.bryant@larc.nasa.gov	

SIMULATOR HARDWARE; SPECIALIZED SIMULATION HARDWARE SYSTEMS; COMPUTER GENERATED IMAGING SYSTEMS; REAL-TIME COMPUTER NETWORKS; SIMULATION SOFTWARE

Structures and Materials Competency — The Structures and Materials Competency conducts research on advanced materials and nondestructive evaluation (NDE) technologies for aircraft and spacecraft structures. Materials research includes development of high-performance polymers, light alloys and composites, and the processing and manufacturing technologies required to improve performance and reduce weight and cost of aerospace structures. Service life testing is performed to establish durability of these materials under simulated aircraft and spacecraft service conditions. Analyses and modeling are performed to predict structural integrity and develop a fundamental understanding of failure mechanisms. Nondestructive evaluation techniques and methodologies are developed to inspect aircraft and space launch vehicle structures.

The Competency also conducts a wide variety of analytical and experimental research aimed toward the development of more efficient structures for aircraft and space vehicles. Research studies focusing on analytical methods for improving structural analysis and design are developed and validated by laboratory experiments. New structural concepts for both metal and composite structures are also developed and evaluated through laboratory testing. Additional research is conducted in integrating advanced structural and active-control concepts to enhance structural performance. Studies of landing and impact dynamics focus on increasing safety during ground operations and crash impact. Research in the aeroelasticity area ranges from unsteady aerodynamics for current and future aircraft and space vehicles to wind tunnel tests of flutter models.

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Edward R. Generazio	Nondestructive Evaluation Sciences Branch	(757) 864-4970	e.r.generazio@larc.nasa.gov

Aerodynamics, Aerothermodynamics, and Acoustics Competency — Opportunities for research exist in the areas of theoretical, computational, and experimental investigations in the areas of aerodynamics for advanced transport and military aircraft; aerothermodynamics for aerospace vehicles and planetary entry systems; hypersonic airbreathing propulsion for hypersonic aircraft and launch vehicles; and fluid mechanics and acoustics for the design of modern aircraft, rotorcraft, missiles, and spacecraft across the speed range. Particular areas of emphasis include configuration aerodynamics; high-lift aerodynamics; component integration; Reynolds number effects; hypersonic aerodynamics and aeroheating; scramjet engine flowpath research; fluid flow physics; high temperature gas dynamics; boundary-layer transition and turbulence; laminar flow control; flow physics; vortical flow control across speed range; aircraft, rotorcraft, and spacecraft noise and its effects on structural integrity, vehicles performance, and passenger and community acceptance; engineering support; advanced concept development; and calibration. Maintains and ensures effective utilization of all Competency wind tunnel facilities. Conducts research and development in the areas of models, instrumentation, data acquisition systems, and test techniques for ground-based labs and wind tunnels to continually enhance wind tunnel productivity, data quality, and customer satisfaction.

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Laurence D. Leavitt	(757) 864-4513	l.d.leavitt@larc.nasa.gov	Configuration Aerodynamics
James L. Thomas	(757) 864-2146	j.l.thomas@larc.nasa.gov	Computational Modeling and Simulations
William L. Sellers, III	(757) 864-2224	w.l.sellers@larc.nasa.gov	Flow Physics and Controls
Joe W. Posey	(757) 864-3618	j.w.posey@larc.nasa.govj.s.preisser@larc.nasa.gov	Aeroacoustics
Kevin P. Shepherd	(757) 864-3575	k.p.shepherd@larc.nasa.gov	Structural Acoustics
Michael A. Marcolini	(757) 864-4581	m.a.marcolini@larc.nasa.gov	Structural Acoustics

Charles G. Miller, III	(757) 864-5221	c.g.miller@larc.nasa.gov	Aerothermodynamics
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Guy T. Kemmerly	(757) 864-5070	g.t.kemmerly@larc.nasa.gov	Data Acquisition
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Mark A. Hutchinson	(757) 864-4642	m.a.hutchinson@larc.nasa.gov	Facility Instrumentation
Mack G. Lawrence	(757) 864-7871	m.g.lawrence@larc.nasa.gov	Research Support (Aerodynamics)
Lynn D. Curtis	(757) 864-6293	l.d.curtis@larc.nasa.gov	Research Support (Gas, Fluids, Acoustics)

Systems Engineering Competency — The Systems Engineering Competency provides aerospace, research facility, and information systems engineering, fabrication, and facility maintenance that enable Agency programs/projects and Center Competencies to meet commitments. The process for systems engineering includes deriving systems requirements from program/project goals, creating design concepts, performing design studies, selecting/implementing design, verifying design, validating design, integrating/testing/activating systems, and maintaining systems.

Flight Systems Technology — The organizations in this technology area pioneer and provide technology, components, and systems in the areas of flight instrumentation, engineering design, and development of flight hardware and research test articles and equipment to sustain Langley's continued research preeminence. The following items represent active research disciplines.

Norman P. Barnes	(757) 864-1608	n.p.barnes@larc.nasa.gov	Solid-State Laser Technology
William B. Cook	(757) 864-8331	w.b.cook@larc.nasa.gov	Fabry-Perot Etalon Technology
James C. Barnes	(757) 864-1637	j.c.barnes@larc.nasa.gov	Solid-State Laser Materials
Upendra N. Singh	(757) 864-1570	u.n.singh@larc.nasa.gov	Lidar Technology
Ira G. Nolt	(757) 864-1564	i.g.nolt@larc.nasa.gov	Far-Infrared Sensor Technology
Stephen G. Jurczyk	(757) 864-1865	Advanced Electronics and Digital Signal	In Situ (Aircraft-Based) Sensors
C. Duane Armstrong	(757) 864-3701	c.d.armstrong@larc.nasa.gov	Signal Conditioning Electronics
Sharon K. Crockett	(757) 864-7167	s.k.crockett@larc.nasa.gov	Systems Engineering Process
William W. Fernald	(757) 864-7081	w.w.fernald@larc.nasa.gov	Mechanical Systems Development
William S. Lassiter	(757) 864-7022	w.s.lassiter@larc.nasa.gov	Thermal, Fluids, and Structural Analysis
Richard A. Foss	(757) 864-7049	r.a.foss@larc.nasa.gov	Environmental Qualification Testing
Elvin L. Ahl, Jr.	(757) 864-7176	e.l.ahl@larc.nasa.gov	Advanced/Miniature Actuators

William C. Wilson	(757) 864-7105	w.c.Wilson@larc.nasa.gov	Microelectronics and Micro-electro Mechanical Systems
David G. Johnson	(757) 864-8580	d.g.johnson@larc.nasa.gov	Fourier Transform Spectrometer Technology
Nural Abedin	(757) 864-4814	n.abedin@larc.nasa.gov	Detector Technology

Advanced Computational Capability — This activity includes computer-generated scientific visualization, image processing, grid generation, numerical techniques for high-performance scientific computers, data modeling, decision support systems, computer networking technology, user interface development, and mass storage techniques.

Ronnie E. Gillian	(757) 864-2918	r.e.gillian@larc.nasa.gov	Scientific Visualization, Image Processing, Grid Generation, Numerical Techniques for High-Performance Scientific Computers
Kennie H. Jones	(757) 864-6516	k.h.jones@larc.nasa.gov	Data Management, User Interface Development
Frank C. Thames	(757) 864-5596	f.c.thames@larc.nasa.gov	Scalable Computing Architectures
Juliet Z. Pao	(757) 864-7328	j.z.pao@larc.nasa.gov	Computer Network Technology

Scientific and Technical Information (STI) Program Office (Lead Center for Agency's STI Program) — This organization leads NASA's program for publishing, collecting, archiving, and disseminating NASA's scientific and technical information (STI) in addition to acquiring STI from more than 40 countries worldwide. The STI Program maintains the STI Database, which involves 3.5 million bibliographic citations and some full-text documents of STI. This activity involves not only skills in communication of information, but also skills in technical support for information dissemination.

George J. Roncaglia	(757) 864-2374	g.j.roncaglia@larc.nasa.gov	Scientific information collection, publication, archival, and dissemination

Facility Systems Engineering — This organization engineers, designs, constructs, and activates aerospace research facilities and associated institutional facilities. Typical products include low and high speed wind tunnel facilities and equipment, including tunnel pressure shells and support systems, tunnel internals, automated control systems, devices to facilitate test measurements, process systems, model handling equipment, and calibration systems. Other typical products include test cells, simulation equipment, environmental test chambers, clean rooms, laboratories with ancillary systems and equipment, robotics systems, and other specialized research test apparatus/equipment.

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Engineering Laboratory — Physical and chemical analytical testing services are needed for the operation of research systems at Langley Research Center (LaRC) and are performed in the Engineering Laboratory. Analytical instrumentation is developed that will advance services at LaRC or will advance technology in aeronautics and space projects. Examples are instrumentation for environmental controls; x-ray fluorescence spectroscopy for lubricant wear metal analysis and for agricultural and planetary geological analysis. Projects such as radiation-induced plasma generation; flow field and temperature visualization for wind tunnel models; carbon nanotube production; and superconductive magnet levitation systems.

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Geographic Information Systems — Research and development of databases and techniques to correlate data to spatial coordinates including the development of intuitive interfaces referenced spatially for decision making for planning, design, maintenance, and any activity requiring large sets of data referenced spatially, e.g., atmospheric sciences, flood and terrain maps, etc.

William B. Ball	(757) 864-7297	w.b.ball@larc.nasa.gov

Fabrication Technology — This technology area provides support in mechanical, electronics, and materials technology support for the Center's engineering and research organizations during the development, fabrication, and testing of research models, flight, and related ground support hardware, facility components, and laboratory test apparatus. The technology area administers contracts of major scope for services and tasks relative to the Center's research manufacturing requirements. Manufacturing standards and quality assurance procedures are established and implemented in accordance with Langley Research Center's Safety, Reliability, and Quality Assurance Program. This technology area determines requirements and initiates procurement of advanced manufacturing equipment and directs the development of fabrication processes applicable to unique materials and applications. It also formulates, establishes, and maintains a direct charge system for fabrication support.

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Atmospheric Sciences Competency — The goal of the Atmospheric Sciences Competency is to conduct research that will establish and maintain a solid foundation of technology embracing all of the disciplines associated with space and atmospheric sciences; and to provide a wellspring of ideas for advanced concepts. These programs include the following disciplines and specific research activities.

Stratospheric Aerosol and Gas Experiment (SAGE) — Analysis and interpretation of atmospheric aerosol, ozone, nitrogen dioxide, and water vapor measured from SAGE I (1979-81) and SAGE II (1984-present) satellite instruments. Studies are directed toward developing global climatologies of these species and understanding the role these species play in atmospheric processes such as ozone depletion and global warming.

Lamont R. Poole	(757) 864-2689

Climate Research Program — Theoretical, laboratory, and field investigations of the radiative properties of natural volcanic and man-made aerosols and assessment of their impact on regional and global climate. Remote and in-situ observations of cloud properties and radiation balance components and theoretical studies of the role played by clouds in the Earth's radiation balance.

Patrick Minnis	(757) 864-5671

Tropospheric Chemistry Research Program — Assess and understand human impact on the regional-to-global-scale troposphere; define chemical and physical processes governing the global geochemical cycles from empirical and analytical modeling studies, laboratory measurements, technology developments, and field measurements; and exploit unique and critical roles that space observations can provide.

James M. Hoell	(757) 864-5826

Upper Atmosphere Research Program — Expand the scientific understanding of the Earth's stratosphere and the ability to assess potential threats to the upper atmosphere. Includes developing empirical and theoretical models, formulating new instruments and techniques, performing laboratory and field measurements, and performing data analysis and interpretation studies.

William L. Grose	(757) 864-5820

Clouds and the Earth's Radiant System (CERES) — Analysis of measurements from instruments on satellites that provide data on clouds and the Earth's radiation budget for assessing climatic impact of human activities and natural phenomena as well as a better understanding of all climatic parameters, in particular, the radiation budget components on a global scale.

Bruce R. Barkstrom	(757) 864-5676

Surface Radiation Budget Climatology Program — Analysis of a long-term global time series of satellite measurements to estimate the surface and top-of-atmosphere solar and thermal infrared energy fluxes; comparison of these estimations to long-term surface and satellite measurements; assessment of balance and variability of these energy fluxes to processes in the atmosphere and at the surface toward understanding climate and climate variability on local to global scales.

Paul W. Stackhouse, Jr.	(757) 864-5368

Halogen Occultation Experiment (HALOE) — Analysis and interpretation of measurements from this experiment on the Upper Atmosphere Research Satellite to improve understanding of stratospheric ozone depletion, particularly the impact of chlorofluoromethanes on ozone by analyzing global vertical profile data of O3, HCl, CH4, H2O, NO, NO2, and HF.

John G. Wells	(757) 864-1859

Global Biogeochemical Cycling — Theoretical and field investigations of the biogeochemical cycling of atmospheric gases, with particular emphasis on the global budgets of oxygen, nitrogen, and carbon dioxide to better understand global change. Field measurements include studies of biogenic emissions of atmospheric gases from the soil and oceans and gases produced and released to the atmosphere during biomass burning, i.e., the burning of the world's forests and grasslands.

Joel S. Levine	(757) 864-5692

Transportation Systems — Future space vehicle concept development, operations, research, and computer-aided design.

Charles H. Eldred	(757) 864-8211

Spacecraft System Studies — Spacecraft concept development studies for Global Change science missions; large Earth orbiting spacecraft and platform systems studies; spacecraft subsystem analyses, performance, and technology assessments; mission design; and computer-aided design and simulations.

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MARSHALL SPACE FLIGHT CENTER

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Mission

The Marshall Space Flight Center offers opportunities for original work in many areas of physical sciences, mathematics, and engineering. Before preparing your proposal, prior discussion with a Center researcher is recommended. In general, Marshall advisors are interested in collaborative efforts with students and their university advisors and will look favorably on proposals that indicate that research time will be spent onsite at the Center.

SAFETY AND MISSION ASSURANCE OFFICE

Reliability Engineering — Research and analysis are conducted to gain an understanding of complex physics of failure mechanisms with the Space Shuttle Main Engine. The use of statistical models, failure mode and effects analysis, and analysis of failure and anomaly reports, as well as applicable generic data, contribute significantly toward the research efforts.

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Quality Assurance Office — Research is performed in areas dealing with software quality control, nondestructive evaluation (e.g., thermography, computed tomography), critical process controls, workmanship standards for state-of-the-art integrated circuit packages used in electronic fabrication, and assessment of critical characteristics in inspection with respect to control of critical items.

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Systems Safety Engineering — Opportunities exist for research in the development and implementation of quantitative and qualitative techniques directed at the identification, evaluation, and control of hazards associated with complex space systems. This includes probabilistic risk assessment, fault tree analysis and applications, interactive hazard information tracking and closure systems, and the identification of conceptual approaches to establishing mission levels and requirements for various types of space missions.

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SPACE TRANSPORTATION DIRECTORATE

Advanced Space Transportation Program Office — Research and development of liquid rocket engines, solid motors and reaction control systems. There are activities in solid and liquid propellant combustion, performance prediction, combustion stability, engine risk management, launch and space vehicle propellant, and pressurization systems. Activities include prediction, analysis, and design of propulsion systems, subsystems, components and launch vehicles, and establishing test, integration, and verification requirements for flight and test bed propulsion systems.

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Advanced Space Transportation Program Office — Magnetic Flux Compression Reactors - Nuclear/chemical pulsed magnetic flux compression reactor concepts are being examined for future spacecraft propulsion and power, assuming that low-yield high-gain microfusion detonations or high magnetic Reynolds number chemical detonations based on high energy density matter (HEDM) can eventually be realized in practice. In particular, reactors are envisioned in which a magnetic field would be compressed between an expanding detonation-driven plasma cloud and a stationary structure formed from a high temperature superconductor. Computational and laboratory-scale experimental research is directed at underlying physical processes such as production and characterization of high magnetic Reynolds number plasma jets, magnetic flux diffusion in high-temperature superconductors and plasmas, and Rayleigh-Taylor interfacial instabilities. System and engineering design issues are also being addressed.

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Propulsion Research Center — Research and development of advanced propulsion systems and revolutionary technologies that will open up space to ambitious human and robotic exploration. A broad range of challenging projects is underway to achieve dramatic reductions in launch costs, routine transportation between Earth and orbit, rapid travel throughout the solar system, and missions beyond the solar system. Activities focus on analytical and experimental research that will ultimately lead to proof-of-concept demonstrations and flight tests of promising technologies. Principal research areas include advanced combined airbreathing/rocket engine cycles using chemical and nonchemical energy sources, beamed energy propulsion, high-energy electromagnetic and plasmadynamic thrusters, space tethers and sails, and high-power density propulsion systems based on fission, fusion and antimatter energy sources. Opportunities also exist for fundamental physics research, which could possibly lead to revolutionary advances in propulsion and motive capability.

G. Schmidt	(256) 544-6055	george.schmidt@msfc.nasa.gov

Propulsion Research Center/Plasma Propulsion — There are two types of plasma propulsion: direct and indirect drives. For direct drive, the energy from a prime source of energy such as fusion is converted into thrust directly by the interaction of the high-temperature plasma created by the energy source with a magnetic field or other force fields. For indirect drive, the energy is first converted into electrical energy and is then conditioned to power an ion or plasma thruster. The latter is the essence of electric propulsion. At MSFC Propulsion Research Center we are engaged in research in both types of plasma propulsion, in collaboration with other NASA Centers, various university and industrial groups and national laboratories. We are particularly interested in those plasma propulsion schemes which have the potential for scalability to extremely high jet power, from 100s kW to in excess of 100s of MW, and involving the application of stable plasma configurations, such as spheromaks and field-reversed configurations, that have a high degree of self-organization of the plasma flows and the self-generated magnetic fields. The ultimate potential of plasma propulsion may be realized by one driven by a fusion energy source. To that end, we are undertaking basic, exploratory, science-based research to explore the most promising physics and engineering pathways to fusion that are particularly adaptable for propulsion.

F. Thio	(256) 544-7094	francis.thio@msfc.nasa.gov

Gasdynamic Mirror Fusion Propulsion Engine Experiment — The Gasdynamic Mirror, or GDM, is an example of a magnetic mirror-based fusion propulsion system. Theoretically, it has been shown that the geometry of the GDM should be effective in preventing the major causes of instability known to plague classical fusion mirror machines. The purpose of the GDM Propulsion Experiment is to confirm the feasibility of the basic concept and to demonstrate many of the operational characteristics of a full-sized engine. This will be accomplished with a small-scale experiment that should determine if a plasma can be confined within the desired physical configuration and still remain stable.

B. Emrich	(256) 544-7504	bill.emrich@msfc.nasa.gov

Propulsion Research Center/Advanced Airbreathing Propulsion — Fundamental research on combustion and fluid mechanics of combustion for various rocket and rocket based airbreathing cycle propulsion systems. Active research topics include combustion characteristics and instabilities of High Energy Density Matter (HEDM) propellants in a gas-fed rocket motor, pulsed detonation propulsion, and rocket based combined cycle propulsion.

J. Blevins	(256) 544-3705	john.blevins@msfc.nasa.gov

Propulsion Research Center — Research involving the performance of a Magnetically Insulated Inertial Confined Fusion propulsion concept that uses antiprotons as an initiator. Work shall involve analytical computational and experimental investigations into both the operational physics and potential hardware requirements behind the system. This work shall take into account the use of existing proton accelerators as simulation devices, the MSFC High Performance Antiproton trap hardware, and potential antiprotons sources at Department of Energy sites.

J. Martin	(256) 544-6054	james.j.martin@msfc.nasa.gov

Propulsion Research Center — Opportunity I. Marshall Space Flight Center is seeking graduate students interested in developing computational models of magnetohydro-dynamic (MHD) generator flows for application to space propulsion concepts. Of particular interest is MHD flows based on non-equilibrium ionization processes, especially ionization due to neutron or energetic charged particle interactions. The computer models will include subsonic and supersonic flows, plasma kinetics, and magnetogasdynamics. Initial modeling will focus on plasma kinetics and quasi-one dimensional internal flow. Modeling techniques for 2-D and 3-D flows will also be considered at later stages of the work. These models will be used for conceptual design performance analysis as well as experiment design and analysis. The student may participate in experimental activities to verify computational results.

Opportunity II. Marshall Space Flight Center is seeking graduate students interested in performing research related to high specific power (kW jet/kg), high specific impulse (Isp > 3000 s) space fission propulsion systems. The student will participate in experimental and theoretical studies needed to estimate the performance potential of the integrated propulsion concept. Innovative approaches for converting fission energy into thrust will be investigated.

M. Houts	(256) 544-7143	michael.houts@msfc.nasa.gov

Propulsion Research Center — Opportunity I. This research is an opportunity for a student to examine supercriticality in a variety of simplified geometries. The student can choose either to work with analytical formulas (i.e., diffusion equation) or run Monte Carlo neutron-transport computer codes. The energy release from a fission assembly is directly proportional to the neutron population. Because fission neutronics involves the study of the distribution of neutrons, their energy and direction, the determination of the neutron field as a function of time allows one to determine the energy produced by the entire chain-reacting assembly. We are primarily interested in the yield from a fast fission assembly. Exponential neutron buildup using fast neutrons leads to extremely high amounts of energy release. This energy release is being investigated as the driver for a spacecraft propulsion system. Using simple generation models, one can determine how much energy is released and expected particle velocities. The student should have an interest in nuclear engineering, nuclear physics, or spacecraft propulsion.

Opportunity II. This research is an opportunity for a student to examine a material under an intense shock wave. The student will mathematically derive the Lagrangian hydrodynamic equations of motion and use computational methods to calculate density profiles of a material under explosive conditions. The Lagrangian method is appropriate when a fixed amount of mass is enclosed within a space of variable size. For example, fuel and air in an engine cylinder or propellant in a gun barrel can be modeled using Lagrangian representation. Using a single differential mass element, the Lagrangian differential formulas for conservation of particle mass, momentum, and energy can be derived for spherical coordinates and spherical symmetry. If coupled with equation of state data and the application of an external force on the surface of a spherical object, it is possible to track material particles that determine the temporal aspects of density, particle speed, and energy. The student should have an interest in applied mathematics.

Opportunity III. This research is an opportunity for a student to learn applied artificial intelligence. The student will learn to build neural network models to model heat rate data. If time permits, a perturbation analysis will also be performed on the input variables. Heat rate, which is proportional to the inverse of efficiency, is the ratio of heat supplied to that of the power output. The term can be applied to a system or individual components, e.g., turbine and unit heat rate. It is an indicator of how well thermal energy is converted to electrical energy. Normally, efficiency or heat rate is determined by performing a full thermodynamic analysis of a power plant's systems. However, newer methods employing artificial intelligence can be used to model heat rate. Since neural networks provide for nonlinear mapping of input variables to a criterion variable, application of neural networks to predict heat rate provide for a much simpler model. A perturbation analysis can later be performed to determine those predictors that have the greatest influence on heat rate.

C. Irvine	(256) 544-4475	claude.irvine@msfc.nasa.gov

Vehicles and Systems Development Department/Guidance and Control Systems — Opportunities for research exist in guidance and control systems analysis and design for launch vehicles, upper stages, various spacecraft, and a variety of space systems. Includes trajectories, orbital mechanics, attitude control, guidance, navigation, automated rendezvous and capture, fine pointing control, microgravity vibration isolation, active optics control, tethered system dynamics and control, POGO stabilization, thermal/process control, and turbomachinery rotordynamic analysis and stabilization.

S. Ryan	(256) 544-1467	steve.ryan@msfc.nasa.gov
J. Hanson	(256) 544-2239	john.hanson@msfc.nasa.gov

Vehicle and Systems Development Department — Two of NASA's goals for the next 10 years are to reduce launch costs by one order of magnitude and at the same time to increase safety by two orders of magnitude. The only way that these significant reductions in cost and increase in safety will be possible is through flight of robust reusable launch vehicles. Flight of reusable launch vehicles, however, is significantly more complicated than flight of expendable launch vehicles.

Research in advanced flight control techniques to increase the safety and reliability of future reusable launch vehicles. The areas of interest include advanced control law development, control allocation and reconfiguration, techniques to accommodate actuator saturation and failure, and techniques to maintain vehicle stability and maneuverability by modifying guidance and control inputs or algorithms based on current vehicle health and status.

D. Krupp	(256) 544-1812	don.krupp@msfc.nasa.gov

Vehicles and Systems Development Department — Microgravity vibration isolation systems and robust control for flexible space structures; g-LIMIT, a microgravity vibration isolation system for the International Space Station Microgravity Science Glovebox.

M. Whorton	(256) 544-1435	mark.whorton@msfc.nasa.gov

Subsystem and Component Development Department — Activities involve research and development of mechanical subsystems such as propulsion feedlines, turbomachinery, combustion devices, thrust vector control, auxiliary propulsion, valves, actuators, controls, and mechanisms. Another area of interest is establishing test, integration, and verification requirements for mechanical elements.

T. Ezell	(256) 544-3620	tim.ezell@msfc.nasa.gov

Subsystem and Component Development Department/Experimental Fluid Dynamics — Opportunities to develop and apply state-of-the-art experimental fluid dynamic methods to study launch vehicle aerodynamic characteristics and rocket engine internal flows. Areas of expertise include external aerodynamics, turbomachinery fluid dynamics, nozzle performance and flow physics, injector flow physics, and other fields involving fluid flow. Research is needed in all of the above areas, as well as data analysis techniques and unique diagnostic systems development.

W. Bordelon	(256) 544-1579	wayne.bordelon@msfc.nasa.gov

Subsystem and Component Development Department/Fluid Dynamics Analysis — Opportunities to develop and apply state-of-the-art computational fluid dynamic (CFD) methods to solve three-dimensional highly turbulent flows for compressible and incompressible, and reacting fluid states, and to provide benchmark CFD comparisons to establish code quality for subsequent application. Research is needed to assess significant aspects of the computational algorithms, grid generation, chemistry and turbulence modeling, code efficiency, and stability and solution visualization.

R. Garcia	(256) 544-4974	robert.garcia@msfc.nasa.gov

Subsystem and Component Development Department — Theoretical and experimental research activities in the field of the optical diagnostics shall focus on the development of combustion flow field measurement techniques. In the course of theses investigations, a UV laser shall be utilized to gain information of Raman scattering signals of combustion products in rocket chamber flow fields. The results, in turn, will provide accurately quantitative interpretation of combustion environments such as spatial species concentration and temperature distributions. Such a technique shall be fully demonstrated to measure in actual rocket test environments.

H. Stinson	(256) 544-7077	henry.p.stinson@msfc.nasa.gov

Technology Evaluation Department — Activities include experimental research and development testing of propulsion systems, subsystems, and components for space systems hardware. Current areas of interest specifically relate to automate test control systems. A continuing interest exists for new and advanced instrumentation techniques.

P. Jones	(256) 544-5716	preston.jones@msfc.nasa.gov

In-Space Transportation/Electrodynamics Tethers — Research and development of Field Emitter Array Cathode (FEAC) systems for space propulsion applications with emphasis to electrodynamics tethers. Work includes particle-in-cell simulations of a variety of FEAC geometries and vacuum chamber tests in several neutral gas constituents at various pressures as well as plasma. Accurate modeling and testing of simulated low earth orbit ionospheric environments. Techniques to achieve high efficiency in power, space, and weight while maintaining robust survivability are pursued.

L. Johnson	(256) 544-0614	les.johnson@msfc.nasa.gov

In-Space Transportation/Electrodynamics Tethers — NASA Marshall presently has a high level of interest in the use of space tethers as transportation elements for in-space transportation. These tether applications involve the use, either separately or combined, of electrodynamic and momentum transfer tether systems. Of particular interest is the rendezvous and capture of payloads with momentum transfer tether systems. There exists a need to develop concepts for capture devices and rendezvous operations. Also, for promising concepts, kinematic and dynamic models of capture devices should be developed and demonstrated through simulation. Valid concepts may be chosen for prototype development and demonstration.

K. Welzyn	(256) 544-1731	ken.welzyn@msfc.nasa.gov

Advanced Concepts Department — Conceptual design and analysis of launch vehicle structures and propellant tankage to include sizing, finite element modeling, and configurations. The analysis will be performed in a quick-turnaround systems environment. Configurations will include expendable rockets, fully reusable rockets and air-breathing concepts.

N. Brown	(256) 544-0505	norman.brown@msfc.nasa.gov

ENGINEERING DIRECTORATE

Avionics Department/Instrumentation and Control — Research, design, and development of instrumentation and control systems for use on space flight vehicles and experiments. Subjects addressed include sensors, transducers, video/imaging systems, guidance, navigation, and control components, reaction wheels, and pointing systems.

J. Zimmerman	(256) 544-3458	joe.zimmerman@msfc.nasa.gov

Avionics Department/Audio Systems — Design, development, and evaluation of flight audio communications systems are performed in support of ongoing and future programs. Specific areas of interest include digital signal processing and encoding techniques, voice synthesis and recognition, and the effect on background noise on intelligibility.

P. Clark	(256) 544-3661	porter.clark@msfc.nasa.gov

Avionics Department/Communications Systems — Test facilities are available to pursue research and development of antenna components and systems. These facilities include a fully automated 800-meter pattern test range and a shielded anechoic chamber with 3.7 meter diameter quiet zone and supporting test equipment operating up to 60 Ghz. Other areas of interest include high-power, solid-state transmitters Tracking and Data Relay Satellite System (TDRSS) transponders, and spread spectrum receivers and Global Positioning System (GPS) receivers. Test facilities are available for Precision Positioning System (PPS) GPS receiver testing and TDRSS transponder testing. A large collection of RF test equipment is available for research and development.

L. Bell	(256) 544-3678	leon.bell@msfc.nasa.gov

Avionics Department/Space Flight Software — Areas of high interest are: use soft computing techniques in the development and verification of mission critical space flight software; verification techniques and methodology for mission critical embedded software; software process improvement including the use of the Capability Maturity Model (CMM); software systems engineering; software metrics; reuse of software requirements and design; automated software development and testing techniques and tools.

T. Crumbley	(256) 544-5978	tim.crumbley@msfc.nasa.gov

Avionics Department/Integrated Devices Laboratory — Produce various MEMS, integrated optics, advanced integrated circuit, and nanotechnology research devices. Collaboration with the academic community in applying electrodes and analysis of the device. Main research task is to develop advanced sensor technologies for space transportation, space exploration, and scientific research. The MEMS technologies have the potential to make a large impact in the space exploration arena.

M. Watson	(256) 544-3186	mike.watson@msfc.nasa.gov
W. Powers	(256) 544-3452	w.t.powers@msfc.nasa.gov

Structures, Mechanics and Thermal Department/Structural Dynamics — Research and development in aerostructural modeling, vibration analysis, and load predictions using simulation of all environments, including propulsion, control, aerodynamics, and atmosphere. Probabilistic, as well as deterministic, approaches are used on SGI workstation computers to simulate flight environments and obtain loads data on launch vehicles and propulsion hardware. Enhanced structural dynamic analysis techniques are pursued.

J. Brunty	(256) 544-1489	joseph.brunty@msfc.nasa.gov

Structures, Mechanics and Thermal Department/Thermal Analysis/Liquid Propulsion Systems — Opportunities for research exist in thermal analysis of liquid propulsion system components, including integrated thermal/structural analysis of turbine section and rotating components in high-pressure turbomachinery and combustion devices. Analytical results may be correlated to ground test data.

B. Tiller	(256) 544-4695	bruce.tiller@msfc.nasa.gov

Structures, Mechanics and Thermal Department/Thermal Analysis/Solid Rocket Motor — Opportunities are available for research in thermal modeling and analysis of solid rocket motor thermal protection systems. Specific areas include the modeling of ablation processes involving a variety of material surfaces and the determination of heat transfer coefficients in radiative, erosive, and chemically reactive environments.

K. McCoy	(256) 544-7211	ken.mccoy@msfc.nasa.gov

Structures, Mechanics and Thermal Department/Structural Design Optimization/Synthesis — In view of the need for lighter, stiffer, and stronger launch and space vehicle structures, new ways of designing structural systems are being sought. Research on the synergistic effects of assembly of structurally optimized elements and components is needed. Efficient and effective design methods and tools using numerical optimization, trajectory analysis, thermal analysis, loads, stress environments, and other critical criteria are needed.

D. Ford	(256) 544-2454	donald.ford@msfc.nasa.gov

Structures, Mechanics and Thermal Department/Structural Assessment/Structural Analysis — Opportunities exist for research in strength, stability, fatigue, and fracture mechanics analyses. Computationally intensive methods such as finite and boundary element analyses are used extensively. Practical enhancement methods are sought such as solution adaptive finite element modeling techniques. Technology improvement in analysis and computational methods, which lead to development of practical engineering tools, are encouraged.

K. Spanyer	(256) 544-6789	karen.spanyer@msfc.nasa.gov

Structures, Mechanics and Thermal Department/Strength Analysis/Liquid Propulsion Systems — Opportunities for research exist in structural analysis of liquid propulsion system components, including integrated structural analysis of turbine section and rotating components in high-pressure turbomachinery. Areas of particular interest involve development of structural integrity and life criteria for exotic materials subject to rocket propulsion environments. Analytical results may be correlated to ground test data.

G. Swanson	(256) 544-7191	greg.swanson@msfc.nasa.gov

Structures, Mechanics and Thermal Department/Vibroacoustics — Mechanically and acoustically induced random vibration and test criteria and response loads analytically derived using advanced computer techniques. Vibration, acoustic, and transient data from engine static firing and Space Shuttle flights are analyzed and categorized. Research opportunities include improved vibroacoustic environment prediction methods, high frequency vibration data analysis techniques, and microgravity characterization.

P. Harrison	(256) 544-1521	phillip.harrison@msfc.nasa.gov

Structures, Mechanics and Thermal Department/Probabilistic Analysis of Aerospace Structures — Probabilistic analysis of aerospace structures has been an ongoing research effort at NASA for the past 10 years. Several different computer codes have been developed: 1) PFA (probabilistic failure analysis using response surface techniques) developed by the Jet Propulsion Laboratory, 2) NESSUS (Finite Element structural computer code) developed by SwRI and NASA Glenn Research Center, and 3) QRAS (Quantitative Risk Assessment System analysis tool) developed by NASA Headquarters and Marshall. In the past, my research has focused on the development of these design tools. Presently, my research in this area is focused on the application of these tools to real aerospace problems.

John Townsend	(256) 544-1499	john.townsend@msfc.nasa.gov

Materials Processes and Manufacturing Department/Space Environmental Effects on Materials — Evaluation of material is accomplished in simulated space environments involving vacuum, temperature, electron/proton and UV irradiation, atomic oxygen, and *plasma.* The effects of outgassing products of materials on weight loss, strength loss, surface properties, and redeposition and condensation on other items are being studied. Studies involving lubrication and surface physics of bearings in space and in rocket propulsion components are also being conducted. Research and development in new nondestructive evaluation (NDE) methods/processes and instrumentation are encouraged.

R. Carruth	(256) 544-7647	ralph.carruth@msfc.nasa.gov

Materials, Processes and Manufacturing Department/Compatibility Testing Methodologies for High-Test Hydrogen Peroxide — High-test hydrogen peroxide is an environmental friendly mono and bi-propellant that is finding applications in future vehicles. In particular this HTP is to be utilized in the X-37 Advanced Technology Demonstrator. This research will develop methods of testing metallic and non-metallic materials that have been exposed to HTP. Also, methods will be developed for testing the effects of materials on the HTP. Results of this work will be foundational to development of new HTP-resistant materials.

R. Gostowski	(256) 544-0458	rudy.gostowski@msfc.nasa.gov

Engineering Systems Department/Environments Group — Performing assessments of the hazard to the International Space Station posed by the Meteoroid and Orbital Debris (M/OD) environment, considering the impact shielding designs on the various modules. Developing the environment definition for the Next Generation Space Telescope, including meteoroids, plasma and ionizing radiation, solar, electromagnetic, and thermal environments.

S. Evans	(256) 544-8072	steve.evans@msfc.nasa.gov

Materials, Processes and Manufacturing Department/Metallic Materials — Development of advanced materials for special applications in space propulsion systems is ongoing. The materials include aluminum-lithium, metal matrix composites and hydrogen resistant alloys. The effect of high-pressure, high temperature hydrogen on metals is an area of special emphasis. Research in microstructural analysis methods is being accomplished in support of failure analysis and materials characterization programs. Methods are being developed for quantitatively determining the state of corrosion, stress corrosion, and hydrogen embrittlement of alloys. Several development efforts are in progress relative to metals processing, including advanced welding methods, intelligent processing, robotics, and sensor development.

B. Bhat	(256) 544-2596	biliyar.bhat@msfc.nasa.gov

Materials, Processes and Manufacturing Department/Casting Process Modeling — Research opportunities exist in casting process modeling using procast software. Pressure infiltration casting process will be modeled for metal matrix composites (MMC) to optimize casting parameters. Different MMCs will be evaluated. The models will be validated through controlled experiments.

B. Bhat	(256) 544-2596	biliyar.bhat@msfc.nasa.gov

Materials, Processes and Manufacturing Department/Fracture Mechanics — Research opportunities exist in advanced modeling and prediction of elastic-plastic fracture in metals. Emphasis will be placed on validation of new computational models within the research codes by comparison with experimental data. Areas of specific interest include advanced cyclic plasticity models, computational models for hydrogen effects on fracture and fatigue, and modeling of fatigue crack growth under elastic-plastic conditions.

D. Wells	(256) 544-3300	doug.wells@msfc.nasa.gov

Materials, Processes and Manufacturing Department/ Welding Process Modeling — Modeling opportunities exist in friction stir welding (FSW) process. FSW process is being expanded from low melting aluminum alloys to higher melting copper alloys. Modeling will help optimize weld parameters, such as tool speed, applied forces in different directions, and preheating conditions. Models will be validated through controlled experiments.

A. Nunes	(256) 544-2699	arthur.nunes@msfc.nasa.gov

Materials, Processes and Manufacturing Department/ Nonmetallic Materials Research — Opportunities exist to develop and evaluate various materials for application in adhesives, elastomers, insulators, composite matrices, and molding and extrusion compounds for use in spacecraft hardware and in special environments. Composites utilizing carbon-carbon, carbon-resin, and ceramic matrix are being developed for applications to reduce mass or for high-temperature applications in rocket engines, structures, and leading edges. Research and technology efforts are underway in composite material fabrication, testing, and qualification for flight hardware application including automated filament winding and tape laying, pultrusion, tape wrapping, fiber placement, and hand lay-up. Additional opportunities exist for the development, application, and evaluation of cryogenic and high temperature thermal protection materials used in association with both liquid and solid propellant rocket motors. Also, use of computer aided engineering for process development and optimization including kinematics simulations.

C. Clinton	(256) 544-2682	corky.clinton@msfc.nasa.gov

Engineering Systems Department/Configuration Management — Configuration management is an essential component of any successful engineering activity. Marshall projects tend to be both large and complex as well as small with short durations, requiring the efforts of teams of both NASA and contractor engineers. The level of control required by space flight makes configuration management a critical activity. Automated tools and improved methods are continually sought.

B. Zagrodzky	(256) 544-0933	bob.zagrodsky@msfc.nasa.gov

Engineering Systems Department/Systems and Components Test and Simulation — Opportunities exist for the development, qualification, integration, and flight acceptance testing of space vehicles, payloads, and experiments. Thermal vacuum testing is conducted in a variety of chambers with capabilities to $1X10^{-7}$ torr pressure and temperature ranges from -170ºC to +204ºC. Facilities exist to calibrate X-ray payloads and scientific instruments utilizing a 518-meter evacuated guide tube.

R. Stephens	(256) 544-1336	randy.stephens@msfc.nasa.gov

Structures, Mechanics and Thermal Department/Structural Dynamics and Loads – Inflatable and thin-film structures have received renewed emphasis in recent years within NASA, the Air Force, and the aerospace industry. These structures have considerable advantages over conventional structures for space applications due to their light weight, small packaging and launch volume, and relative simplicity of deployment systems. A number of proposed future space missions potentially can benefit from use of thin-film and inflatable structures, including solar sails, solar thermal propulsion vehicles, space solar power systems, large space telescopes, and communications antennas. These future missions fall within MSFC's priorities of Space Transportation and Space Optics. Possible research and development activities that can be performed in this project include the following:

a. Investigation of rigidization concepts for inflated thin-film or composite fabric structures, including

    (1) foam injection, either following inflation on-orbit or used as the means of inflation,
    (2) foam packaged in-place prior to launch, to be rigidized on-orbit,
    (3) thin lightweight metal film or wire grid, to be enclosed between layers of film or fabric and rigidized through over-inflation and plastic deformation, and
    (4) various other approaches for chemical rigidization, such as resin- or gel-impregnated fabrics or resin-coated films.

b. Development of linear and nonlinear finite element modeling approaches for structural dynamics, stress, and buckling analyses of thin-film and inflatable systems.

c. Investigation of testing techniques for structural dynamics, buckling, and load-to-failure.

d. Development of packaging/deployment concepts for thin-film and inflatable structures, and test/analysis methods for deployment characterization.

M. Tinker	(256) 544-4973	mike.tinker@msfc.nasa.gov

SCIENCE DIRECTORATE

Microgravity Science and Applications Department/Biophysics — An opportunity exists to conduct research in the separation and purification of biological cells and proteins to develop a basic understanding of the separation phenomenon. The proposed research should include analysis of the fundamental behavior of a separation process by theoretical and/or experimental methods. A second activity involves laboratory and space experiments in protein crystal growth. High quality single crystals are required to obtain the three-dimensional structure of the proteins, and Shuttle space experiments confirm the advantages of the microgravity environment. Projects include experiments to define improved crystallization conditions and the analysis of crystals by X-ray diffraction and factors that affect the crystal growth process and quality of crystals obtained.

M. Pusey	(256) 544-7823	marc.pusey@msfc.nasa.gov

Microgravity Science and Applications Department/Semiconductor Crystal Growth and Characterization — Theoretical and experimental research is conducted on the effects of gravity on the crystal growth of semiconductors including model systems. Both the preparation and the characterization of materials are important. The areas of research include solid-state physics, chemistry, surface physics, solidification phenomena, fluid modeling, analysis of crystal growth, and characterization techniques. The well-equipped laboratory includes directional solidification and vapor growth apparatus including magnetic damping to five Tesla; extensive sample preparation facilities; and optical, x-ray, electronic, and electron-microscopic characterization equipment.

F. Szofran	(256) 544-7777	frank.szofran@msfc.nasa.gov

Microgravity Science and Applications Department Microgravity Solidification: Contained Solidification of Metals and Alloys — Buoyancy driven convection and sedimentation in the melt during metal and alloy solidification strongly influence the microstructure and thus important physical properties of the solid product. Also, under normal gravity, convection and sedimentation can mask the fundamentals of solidification that must be understood to allow the precise control of microstructure that can tailor materials properties. Current flight and ground experiments study phenomena such as dendritic growth, particle pushing and engulfment by solidifying interfaces, formation of eutectic and monotectic composite structures, and the transition from planar to cellular growth (morphological instability). Better experimental and theoretical methods are needed. Theory for all of the above mention processes must be reconciled with new experimental data. Experimental methods are being improved by such techniques as utilizing solid/liquid interfacial Seebeck measurements for undercooling and X-ray transmission microscopy for real-time imaging of solidifying microstructure and solute concentration in the liquid.

P. Curreri	(256) 544-7763	peter.curreri@msfc.nasa.gov

Microgravity Science and Application Department/Macromolecular X-Ray Crystallography — Macromolecular X-ray crystallography is a powerful method for studies of structures of proteins, nucleic acids and their assemblies for a better understanding of biological processes at the molecular level, the development of pharmaceutical drugs, bioengineered products, and new technologies. Our research is focused on the structural determinations of large protein complexes, including pyruvate dehydrogenase complex. We are also interested in phosphatases involved in the inhibition of the proliferation of tumor cells. We have additionally developed instrumentation for X-ray crystallography that can be conducted in remote environments, such as the International Space Station.

Ewa Ciszak, Ph.D.	(256) 544-5531	ewa.ciszak@msfc.nasa.gov

Microgravity Sciences and Applications Department/Optics — Opportunity I. Opportunities exist in the nanophase optical materials group for research in nonlinear optical spectroscopy and characterization, fluorescence spectroscopy, light-scattering, composite and nanophase materials, and sol-gel science. Examples of research topics include chromatographic methods for determination of pore-size distribution in sol-gels, time-resolved fluorescence spectroscopy for the study of protein aggregation and crystallization, linear and nonlinear optics of metal clusters, and optical trapping experiments.

Opportunity II. Perform novel experimental and theoretical research in optics, particularly on composite materials, which include quasi-fractal line materials such as sol-gels and other aggregated or porous media, statistically random cluster media such as metal colloids, and highly ordered materials such as layered media and colloidal crystalline arrays. Application of novel optical techniques to gravitationally sensitive and highly nonlinear materials (for example protein crystals and organic polymers) in ground-based and flight experiments, such as interferometry, holography, light scattering, nonlinear optical techniques such as phase conjugate interferometry, wave-mixing, z-scan, pump-probe, and ultra fast fluorescence experiments. Investigate effects such as self-phase modulation, two-photon absorption, bistability, and local fields.

D. Smith	(256) 544-7778	david.d.smith@msfc.nasa.gov

Microgravity Science and Applications Department/Polymers — Development of nonlinear optical (NLO) polymers and the study of the processing of such polymers into thin fibers by means of solution-based extrusion techniques. The initial phase of the work will be ground-based, but will be followed by microgravity studies on those materials that show the most promise. The research will proceed on two fronts: synthesis and characterization of new materials, and development of fiber extrusion capabilities. The polymers will be diacetylene based because they are known to be excellent NLO materials. The fibers produced in this research project will be tested for their ability to waveguide light, and their ability to process information by all-optical techniques.

D. Frazier	(256) 544-7825	don.frazier@msfc.nasa.gov

Microgravity Science and Applications Department/Polymer Science — Current research efforts include the development of organics, polymers, sol-gels and nanocomposites for nonlinear, photorefractive, and optical limiting applications. There is interest in the development of materials for biomedical and radiation shielding applications. Work includes a CDDF project involving the development of technology that may enhance the capability of man to have a long-term presence on the Moon and Mars. This involves the development of aerogel molds for metal casting using Lunar and Martian soil.

B. Penn	(256) 544-7809	ben.penn@msfc.nasa.gov

Microgravity Science and Applications Department — Solidification processing, particularly in utilizing controlled directional solidification techniques; studies on monotectic, eutectic, dendritic, and composite solidification, both in metal alloys and in transparent, analogous systems.

R. Grugel	(256) 544-9165	richard.grugel@msfc.nasa.gov

Space Science Department/X-ray Astronomy — Experimental, observational, and theoretical research is conducted in x-ray astronomy and high-energy astrophysics. The experimental program concentrates on development of replicated x-ray optics, polarimeters, and hard-x-ray imaging detectors operating from 1 keV to above 100 keV using microscrip and liquid-xenon technologies. Observational and theoretical specialties comprise the study of compact objects (neutron stars and black holes), cooling flows in clusters of galaxies, and astrophysics of high-temperature plasmas. Opportunities include participation in balloon flights of sensors, CXO and other satellites, theoretical studies of physical processes in high-temperature astrophysical plasmas, and observations of clusters of galaxies and the Sunyaev-Zeldovich effect.

M. Weisskopf	(256) 544-7740	martin.weisskopf@msfc.nasa.gov

Space Science Department/Gamma Ray Astronomy — Gamma ray astronomy uses space-borne and balloon-borne experiments to detect hard x-rays and gamma rays above 20 keV. Most of the present research uses data from the Burst and Transient Source Experiment (BATSE) on the Compton Gamma Ray Observatory, although data from other spacecraft are also used. New detectors for observations of gamma-ray sources >20 MeV are being developed and proposed. These detectors use scintillation fibers as the primary detector.

The primary astrophysical sources studied include gamma-ray bursts, galactic jets, black hole systems, accreting pulsars, solar flares, as well as the study of variability and spectra of other sources. Opportunities for participation in the development of a new generation of instruments for future gamma-ray astronomy experiments are also possible.

J. Fishman	(256) 961-7691	jerry.fishman@msfc.nasa.gov

Space Science Department/Space Plasma and Upper Atmospheric Physics — We seek to better understand, and ultimately to predict the flow of matter, momentum and energy through the region in which the Sun-Earth connection is made: the Earth's magnetosphere and ionosphere. We further seek to better understand basic physical processes that effect the operation of spacecraft in space and that are important in astrophysical plasmas; for example cometary, planetary, and stellar upper atmospheres. Plasma and gas dynamic processes are studied by means of in situ plasma measurements, and by remote optical and electromagnetic sensing of the constituent plasmas and gases. Activities include design, development, and calibration of flight instrumentation, with analysis and interpretation of the resulting data in terms of physical models.

P. Craven	(256) 961-7639	paul.craven.msfc.nasa.gov

Space Science Department/Space Plasma Physics — Research activities are primarily focused on the study of physical processes involving low energy plasma in near Earth space. Data analysis and modeling has lead to a statistical, static model of thermal plasmas near the Earth, as well as time-dependent simulations. Measurements of the space environment are available from the Dynamics Explorer 1, POLAR, and IMAGE spacecraft. IMAGE is the first to provide global images of space plasmas using ultraviolet light, neutral atoms, and radio sounding. Opportunities exist for supporting data analysis, computer modeling, visualization, and public outreach of science research. Images from the IMAGE spacecraft are being analyzed to identify features and to derive the distribution of plasma through image inversion.

D. Gallagher	(256) 961-7687	dennis.gallagher@msfc.nasa.gov

Space Science Department/Solar Physics — The influence of the magnetic field on the development and evolution of solar atmospheric structure, from the photosphere to the outer heliosphere, is studied. The primary data are vector magnetograms obtained at Marshall's Solar Observatory, which are supplemented by data from the Yohkoh, SoHO, Ulysses, TRACE, and the GONG programs. The observations are complemented by theoretical studies to characterize the nonpotential nature of solar magnetic fields. This includes the development of MHD (magnetohydrodynamic) codes designed to simulate both coronal and large-scale interplanetary phenomena. Instrument development programs in optical polarimetry, grazing and normal incidence X-ray optics, and imaging detectors for the X-ray and UV spectral regions are being pursued.

D. Hathaway	(256) 961-7610	david.hathaway@msfc.nasa.gov

Space Science Department/Cosmic Ray Research — Cosmic ray research at MSFC emphasizes the study of the chemical composition and energy spectra of cosmic ray nuclei above 1012 eV (TeV). Study of the interactions of heavy cosmic ray nuclei are also carried out to determine the behavior of nucleus interactions and to search for evidence of new states of nuclear matter. The research involves experiments with emulsion chambers and with electronic counters, exposed on balloons at about 40 kilometers altitude for up to two weeks. Research includes laboratory work, data analysis, particle cascade calculations, and calibrations of instruments with particle accelerators.

M. Christl	(256) 544-9496	mark.christl@msfc.nasa.gov

Space Science Department/Astrobiology — Astrobiology is the scientific study of the origin, distribution, and destiny of life in the universe and the exploration of the spatial, temporal, physical and environmental limits of life on Earth. The analogues developed may shape future space instrumentation and missions searching for evidence of extant or extinct life elsewhere in the Cosmos. Astrobiology also seeks to locate other planets and bodies in the Universe that may presently support (or previously have been capable of supporting) biology. Astrobiology seeks answers to the fundamental question — Is Life a Cosmic Imperative? Activities include the use of advanced Electron Microscopy, X-Ray Spectroscopy, and Computer tools to explore chemical and morphological biomarkers and microfossils in ancient rocks and astromaterials. Ancient viable microorganisms from glaciers, permafrost and the deep ice just above Lake Vostok in Antarctica are being actively explored as models of microbial life that might be found on other Solar System bodies. The study of terrestrial extremophiles is necessary to understand where and how we should search for evidence of microbial life on Mars, Europa, Io, Callisto, asteroids, comets, and other potential habitats of the Cosmos.

R. Hoover	(256) 544-7617	richard.hoover@msfc.nasa.gov

Space Sciences Department/Astrophysics — Research areas include x-ray astrophysics, using the Chandra X-ray Observatory to perform imaging spectroscopy of clusters of galaxies; experimental cosmology, using interferometric measurements of the Sunyaev-Zeldovich Effect; and development of advanced x-ray optics for future missions.

M. Joy	(256) 544-3423	marshall.joy@msfc.nasa.gov

Earth Science Department/Aerosol Backscatter and Doppler Wind Lidar Studies — The research focuses on the assessment of regional global and patterns of aerosol backscatter, the calibration and characterization of Doppler Lidar systems, and the development and scientific application of ground-based, airborne, and space-based Doppler Lidars for the determination of regional and global winds relevant to contemporary issues in atmospheric research. Major experimental efforts have included ground-based and airborne Doppler Lidar systems for backscatter and wind fields, intensive field campaigns, and a host of supporting aerosol sensors. Laboratory facilities exist for detailed calibration of short-focal length lidars, and for analysis of the optical properties of artificially generated aerosols resembling those found in nature. A major facility addition is planned to accommodate multiple (active and passive optical) remote sensors as part of a cooperative initiative for regional modeling and assessment studies for air pollution and land use, and inputs to satellite validation.

J. Rothermel	(256) 961-7965	jeff.rothermel@msfc.nasa.gov
M. Jarzembski	(256) 961-7964	maurice.jarzembski@msfc.nasa.gov

Earth Science Department/Severe Storm and Hydrometeorology Studies — This research is directed towards understanding storm and precipitation processes and their relation to the larger scale environmental forcing. Cloud microphysics, lightning, precipitation processes, storm kinematics, and morphology studies are conducted using ground-based and satellite (TRMM, GOES) research data acquired during field campaigns. Ancillary data from satellite and airborne microwave and imaging remote sensor data are used to further describe the convective processes. Data collected from the operational National Weather Service WSR88-D (NEXRAD) network are used to develop instantaneous and climatological rainfall estimates and water budgets to study flash floods and the interannual variability of rainfall and its relation to changes in the synoptic and general circulation. This research will lead to improved understanding of precipitation processes and algorithms developed for new satellite sensor suites.

S. Goodman	(256) 961-7891	steve.goodman@msfc.nasa.gov

Earth Science Department/Hydrometeorology/Land Surface Interface — Earth's surface characteristics and their linkages to the atmosphere and hydrologic cycles are being analyzed and modeled using remotely sensed data. Measurements from satellite and aircraft sensors, in conjunction with in situ measurements, are used to study spatial and spectral resolution and temporal variability effects on determination of land surface energy fluxes, hydrometeorological characteristics, and biophysical components. The effects of spatial and temporal scale on land surface interface processes are assessed using mesoscale hydrometeorological and Global Circulation Models. Geographic information systems play an important research role in integrating and modeling remote sensing and ancillary data for analysis of the spatial and temporal dynamics of land surface hydrometeorological interactions.

D. Quattrochi	(256) 961-5887	dale.quattrochi@msfc.nasa.go v

Earth Science Department/Global Passive Microwave Studies — The Defense Satellite Meteorological Program has launched a series of satellites with passive microwave sensors. These instruments (Special Sensor Microwave Imager, Special Sensor Microwave Temperature-1 and Special Sensor Microwave Temperature- 2) are used to detect and measure atmospheric temperature and moisture profiles, bulk atmospheric water vapor and cloud liquid water amounts, precipitation, and land surface temperature and type. Future research in the usage of one or a combination of these data sets for global multiyear or seasonal assessments of hydrometeorological parameters is desired.

M. Goodman	(256) 961-5890	h.michael.goodman@msfc.nasa.gov

Earth Science Department/Atmospheric Electricity Studies — Interest in lightning as a remote sensing measurement and variable of global change has grown with the recognition that lightning can convey useful information about many atmospheric processes. In the atmospheric electricity program, lightning relationships and practical algorithms are being pursued for processes within hydrology (e.g., distribution, amount and rate of convective rainfall; ice flux to upper troposphere), atmospheric energetics (e.g., release and transport of latent heat; large-scale circulations), atmospheric chemistry (e.g., production and transport of NOx and other trace gases), and the atmospheric electrical environment (e.g., global electric circuit). Modeling, analytic, and observational approaches are used in these studies, which fuse lightning observations with ancillary measurements. The Optical Transient Detector (OTD), the Lightning Imaging Sensor (LIS) on the

Tropical Rainfall Measuring Mission (TRMM) and future space-based instruments play an important role in this research. Additional information can be found on the web at http://thunder.msfc.nasa.gov/.

R. Blakeslee	(256) 961-7962	rich.blakeslee@msfc.nasa.gov
S. Goodman	(256) 961-7891	steve.goodman@msfc.nasa.gov
H. Christian	(256) 961-7828	hugh.christian@msfc.nasa.gov

Earth Science Department/Microwave Measurements — Acquisition and analysis of aircraft and satellite microwave radiometer measurements lead to further understanding of the microphysical processes of precipitation systems and aid in monitoring global climate change. In this research, aircraft measurements are used to investigate the spatial and temporal structure of precipitation systems, improve inversion techniques for precipitation estimation, for the polarametric retrieval of surface wind velocity over oceans, and for increasing the understanding of heating profiles in tropical atmospheres. Pioneering work with the multiyear MSU satellite data sets are used for global temperature and precipitation studies.

R. Spencer	(256) 961-7960	roy.spencer@msfc.nasa.gov

Earth Science Department/Atmospheric Chemistry — Measurements of trace species and temperature in the upper troposphere, stratosphere, and mesosphere have been made from the Space Shuttle and other space platforms. These measurements are utilized to study the interactions between chemistry, dynamics, and radiation that are important in Earth's physical climate system. Especially important are the varying concentrations of stratospheric ozone that are determined by these interactions. This research effort utilizes space-based observations along with detailed models of the atmosphere to better understand the processes that determine stratospheric ozone, the interactions between the troposphere and stratosphere (including the role of water vapor), and the influence that human activities have on the atmosphere through the release of chemicals.

T. Miller	(256) 961-7882	tim.miller@msfc.nasa.gov

Earth Science Department/Climate Diagnostics and the Global Hydrologic Cycle — Observational, numerical modeling, and analytical approaches are used to study the Earth's physical climate system. Diagnostic analyses of space-based observations are used to understand and validate models of global hydrologic cycle. Numerical models ranging in scope from atmospheric general circulation codes to mesoscale and cloud models are used to study water cycle processes and to quantify their role in climate. Sensitivity studies of climate models to surface boundary forcing, i.e., sea surface temperature, albedo and soil moisture anomalies are conducted. Simulations of remote sensors are used to understand how space-based observations can be best applied to studying the Earth as a system.

P. Robertson	(256) 961-7836	pete.robertson@msfc.nasa.gov

Earth Science Department/The Role of Global Hydrology and Climate Variability in Human Ecology and Archeology — The study of global hydrology and climate change is directed at understanding how changes in climate can be understood and potentially predicted. A study of past climates and cultures documents the effects of human/environmental interaction. Understanding how prehistoric cultures adapted to their environments through resource management and population dynamics is critical for societies today. Using remote sensing and GIS technology, this research investigates the adaptation techniques of prehistoric societies and compares the resultant success and failure of those techniques with the environmental and socioeconomic trends of current populations.

T. Sever	(256) 961-7958	tom.sever@msfc.nasa.gov

Earth Science Department/Water Vapor, Winds, and Climate Variability — Water vapor is one of the most important greenhouse gases and is a key component of the Earth's hydrologic cycle, yet our inability to accurately measure it and monitor its variability around the globe is a limiting factor in understanding climate processes. This research focuses on the measurement and validation of atmospheric water as measured from satellites and the use of water vapor imagery for the determination of winds on a global and regional basis. Data from U.S., Japanese, Chinese, and European satellites are used for regional and hemispheric analysis in support of climate studies.

G. Jedlovec	(256) 961-7966	gary.jedlovec@msfc.nasa.gov

Earth Science Department/Retrieval and Use of Land Surface Temperature from Satellite Data — This research focuses on retrieving land surface temperature from satellite radiance measurements for assimilation into numerical forecast models and for use in long-term climate monitoring. Evaporation of water from vegetation controls the physical temperature of the surface and can be monitored from satellite. The change in this temperature throughout the day is related to the flux of moisture from the surface, a parameter that is currently not well specified in regional numerical forecast models. The use of this new satellite information in the models has shown substantial improvement in the prediction of low-level temperature and moisture, cloud fields and subsequent precipitation.

R. Suggs	(256) 961-7895	ron.suggs@msfc.nasa.gov

Earth Science Department/Thermal Remote Sensing & Surface Energy Budgets — Thermal remote sensing research involving the modeling of forest canopy thermal response using both aircraft and satellite thermal scanners on a landscape scale. These investigations have resulted in the development of a Thermal Response Number (TRN), which quantifies land surface's energy response in terms of kJ m-2 C o -1 which can be used to classify land surfaces in regional surface budget modeling by their energy use. A logical outgrowth of characterizing surface energy budgets of forests is the application of thermal remote sensing to quantify the urban heat island effect. These models provide the ability to quantify the importance of trees in keeping the city cool and determine mitigation strategies to reduce ozone production through the use of high albedo surfaces for roofs and pavements and increasing tree cover in urban areas to cool cities.

J. Luvall	(256) 961-7886	jeff.luvall@msfc.nasa.gov

Space Science Department/Large Aperture Optics — This research is directed toward developing the next generation of space based optical imaging devices. Current research involves electroforming lightweight astronomical telescope mirrors (<5kg/m^2), designing and fabricating ultra-lightweight thin membrane mirrors (<100g/m^2), correcting optical figure of lightweight mirrors, and understanding the dynamics of lightweight mirrors and metering structures. Current projects involve the production of super-alloy mirrors, understanding lattice strain in deposited materials, and designing an inflatable space telescope OTA. Research is also being carried out in ION figuring, novel biologically-based radiation dosimeters, zero gravity Atomic Force Microscopy, and other areas in optics and physics

R. Jones	(256) 544-3191	ruth.jones@msfc.nasa.gov

Space Optics Manufacturing Technology Center/Optical Systems — Opportunities exist for research, development, and application of technology in the following areas: coherent lidar systems (both gas and solid state technologies) target and detector calibration, transmitter evaluation signal processing atmospheric propagation and system modeling; video/film camera systems, including imaging systems development fiber optics video compression, radiometry, film camera and video system evaluation; and optical design, fabrication and testing including stray light analysis and testing, performance analysis, coating metrology, precision engineering and binary optics.

J. Bilbro	(256) 544-3467	james.w.bilbro@msfc.nasa.gov

Space Optics Manufacturing Technology Center/Precision Engineering, Diamond Turning Research — Developing and proving manufacturing strategies for the production of Wolter Type I x-ray optic mandrels used to produce x-ray optics in support of the Constellation X program. Other important areas of research include: the dynamic effects of diamond turning large pieces needed to produce large aperture, lightweight space optics, diamond turning machine optimization, Fresnel optic mold fabrication [previously for the Shooting Star Program, currently in support of the Orbiting Wide Lens Array (OWL)]. Fresnel optic mold fabrication research is also conducted.

D. Lehner	(256) 544-9033	david.lehner@msfc.nasa.gov

FLIGHT PROJECTS DIRECTORATE

Training/Training Systems — Training on payload operations is provided for the payload crew, payload flight controllers, and investigators using computer simulations, computer-aided training, mock-ups and/or engineering models. Continuous improvement requires that training methods and tools be assessed and updated on a periodic basis. This includes improving methods to acquire, organize and deliver training materials using recent improvements in multimedia technology and assistance from artificial intelligence technology. These updates are based on improved capabilities/technology, current information relative to pedagogy and lessons learned from previous training.

D. Underwood	(256) 544-2191	debrah.underwood@msfc.nasa.gov
S. Noneman	(256) 544-2048	steve.noneman@msfc.nasa.gov

Ground Support Systems — The Huntsville Operations Support Center is the ground facility that supports multi-project flight operations. The design and development function includes communications (voice, video, wideband data handling, and external information transfer), data acquisition and processing, payload and spacecraft commanding user workstation data presentation, and facility support functions. Development includes prototyping new technologies to ensure state-of-the-art capabilities, with special emphasis on remote operations linking multiple ground facilities. The facility is managed and operated in support of project and user requirements.

K. Cornett	(256) 544-4321	keith.cornett@msfc.nasa.gov

Human Factors Engineering/Human-Computer Interfaces/Virtual Reality — Opportunities for research exist in human factors engineering (HFE), human-computer interfaces and interactions (HCI), and applied virtual reality (VR). New tools and techniques, especially computer-aided capabilities, need to be developed and/or validated to enhance/facilitate the application of HFE to the design, development, test, and evaluation of space systems. More effective HCI design methodologies and more efficient, distributed usability evaluation capabilities are needed for International Space Station experiment displays. Improved systems, components, software, and methodologies are needed to apply VR to design analysis, operations development and support, and training.

J. Hale	(256) 544-2193	joseph.p.hale@msfc.nasa.gov

Expert Systems — New software methods are needed to automate and simplify increasingly complex ground support tasks associated with spacecraft and payload flight operations. Projects in the areas of automated analysis of engineering and operations telemetry, decision support, and trend analysis.

M. McElyea	(256) 544-2034	mark.mcelyea@msfc.nasa.gov

Operations Analysis — Operations analysis in support of flight and ground system development is performed using analytical techniques, mock-ups, and computer simulations. Flight control methods are developed and recommended based upon flight system requirements and objectives.

M. McElyea	(256) 544-2034	mark.mcelyea@msfc.nasa.gov

STENNIS SPACE CENTER

PROGRAM ADMINISTRATOR

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MISSION

The Stennis Space Center (SSC) is located about 25 miles northwest of Bay St. Louis on the Mississippi Coast. It is NASA's primary center for testing and flight certifying rocket propulsion systems for the Space Shuttle and future generations of space vehicles. Because of its important role in engine testing for more than three decades, Stennis Space Center has been designated NASA's Center of Excellence for rocket propulsion testing. Stennis is also NASA's lead center for rocket propulsion testing with total responsibility for conducting and/or managing all NASA propulsion test programs.

Stennis Space Center tests all Space Shuttle Main Engines. These high-performance, liquid-fueled engines provide most of the total impulse needed during the shuttle's eight and one-half-minute-flight to orbit. All shuttle main engines must pass a series of test firings at Stennis Space Center prior to being installed in the back of the orbiter.

Stennis Space Center is also NASA's lead center for Earth Science Applications. Four themed areas serve as the foci for research topic areas: 1) Environmental quality, 2) Resource management, 3) Community development, and 4) Disaster management. SSC also works with the geospatial information industry to assist companies involved in environmental consulting, land use planning and natural resource management. Through these co-funded partnerships, companies use NASA-developed technology to develop information products.

SSC is unique in that NASA serves as host to 22 other federal and state agencies and university elements located at Stennis, including the U.S. Navy's world-class oceanographic and meteorological command.

PROPULSION TECHNOLOGY

Thrust Measurement System — Research opportunities exist to develop innovative thrust measurement systems. New thrust measurement systems for rocket engine testing need to offer greater flexibility and adaptability to changing test requirements. The current technology requires 18 months or more to design and fabricate thrust measurement systems. Requirements for thrust measurement systems include: ½% accuracy or better, ability to measure side loads during engine gimbling, and the ease of manufacture, installation and calibration. Three ranges of thrust measurement will be required for future programs: 20,000 to 100,000 pounds, 100,000 to 1,000,000 pounds, and 1,000,000 to 2,000,000 pounds.

William St. Cyr	(228) 688-1134	William.St_Cyr@ssc.nasa.gov

Cryogenic Instrumentation and Cryogenic, High Pressure, and Ultrahigh Pressure Fluid Systems — Over 40 tons of liquefied gases are used annually in the conduct of propulsion system testing at the Center. Instrumentation is needed to precisely measure mass flow of cryogen's starting at very low flow rates up to very high flow rates at pressures to 15,000 psi. Research, technology, and development opportunities exist in developing instruments to measure fluid properties at cryogenic conditions during ground testing of space propulsion systems. Both intrusive and nonintrusive sensors, but especially nonintrusive sensors, are desired.

Robert Field	(228) 688-3735	Robert.Field@ssc.nasa.gov

Vehicle Health Management/Rocket Exhaust Plume Diagnostics — A large body of UV-Visible emission spectrometry experimentation is being performed during the 30 or more tests conducted each year on the Space Shuttle Main Engine at SSC. Research opportunities are available to quantify failure and wear mechanisms, and related plume code validation. Related topics include combustion stability, mixture ratio, and thrust/power level. Exploratory studies have been done with emission/absorption spectroscopy, absorption resonance spectroscopy, and laser induced fluorescence. Only a relatively small portion of the electromagnetic spectrum has been investigated for use in propulsion system testing and exhaust plume diagnostics/vehicle health management.

J. Fernando Figueroa	(228) 688-2482	Fernando.Figueroa@ssc.nasa.gov

Active and Passive Nonintrusive Remote Sensing of Propulsion Test Parameters — The vast amount of propulsion system test data is collected via single channel, contact, intrusive sensors and instrumentation. Future propulsion system test techniques could employ passive nonintrusive remote sensors and active nonintrusive remote sensing test measurements over wide areas instead of at a few discrete points. Opportunities exist in temperature, pressure, stress, strain, position, vibration, shock, impact, and many other measured test parameters. The use of thermal infrared, ultraviolet, and multispectral sensors, imagers, and instruments is possible through the SSC sensor laboratory.

William St. Cyr	(228) 688-1134	William.St_Cyr@ssc.nasa.gov

Ground Test Facilities Technology — Ground test facilities seldom keep pace with propulsion system development programs partly because the facility is usually designed before the test requirements are known and because test facilities are usually extant and inflexible. An innovative approach to producing flexible, easily adaptable ground test facilities is highly desirable. Research opportunities are also available for developing uncertainty models of test facility systems. Additional opportunities exist in developing altitude simulation and self-pumping diffusers for large rocket propulsion system tests.

Donald Chenevert	(228) 688-3126	Don.Chenevert@ssc.nasa.gov

Advanced Propulsion Systems Testing — Innovative techniques will be required to test propulsion systems such as advanced chemical engines, single-stage-to-orbit rocket plane components, nuclear thermal, nuclear electric, and hybrids rockets. With a shrinking budget and longer lead times to develop new propulsion systems, new approaches must be developed to test future propulsion systems. The solution may be some combination of computational-analytical technique, advanced sensors and instrumentation, predictive methodologies, and possibly subscale tests of aspects of the proposed technology.

Robert Field	(228) 688-3735	Robert.Field@ssc.nasa.gov

Propulsion Test Research in Thermal and Acoustic Environment - Prediction and Control — Testing of large rocket engines produces damaging thermal and acoustic environments on facilities and the test articles. Advanced prediction and mitigation technologies for these environments are needed. Test programs for rocket propulsion systems employ very large flame deflectors and diffusers to control, deflect, cool, condition, and reduce the sound level of the plume. Innovative thermal protection tiles, coatings, materials, and insulation systems could result in significant savings.

Peter Sulyma	(228) 688-1920	Peter.Sulyma@ssc.nasa.gov

TECHNOLOGY TRANSFER

Marketing Strategies — The design and development of marketing strategies to effectively promote and transfer a variety of technologies to the commercial sector. The design and development of methods/techniques to accurately capture economic impact of technology transfer initiatives.

Kirk Sharp	(228) 688-1914	Kirk.Sharp@ssc.nasa.gov

EARTH SCIENCE APPLICATIONS

Earth Science Research Applications — Among the activities that will be conducted in this program as NASA's lead center for Earth Science Research Applications is the selection of relevant research and the validation and verification of remote sensing data acquired from a range of sensors that may lead to successful applications in four theme areas:

- **Environmental Quality**, which covers both air and water quality, and the effect of natural and man-made changes in the landscape on the environment.
- **Resource Management** including natural resource as well as renewable economic resources such as agriculture, forestry, and fisheries.
- **Community Development** focusing on land use, transportation, infrastructure, cultural and recreational resources, and issues of quality of life in our communities.
- **Disaster Management** which encompasses natural disasters, such as volcanic eruptions, earthquakes, sever weather and floods, as well as ecological issues related to the health of human, plant and animal communities.

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Nathan Sovik	(228) 688-7355	Nathan.Sovik@ssc.nasa.gov
Marco Giardino	(228) 688-2739	Marco.Giardino@ssc.nasa.gov

Remote Sensing and Plant Physiological Ecology — The detection of plant radiative responses to growth conditions remains a major goal in remote sensing research. This is true particularly with respect to early detection of plant stress. We are interested in the continued study of leaf and canopy reflectance responses to various stress agents, and the development of techniques to enable the earliest possible detection of stress. This has involved the identification of narrow spectral bands in which reflectance is most strongly affected by various stress agents. We also are continually interested in basic influences on leaf radiative properties, and their relationships to leaf chemical content and physiological processes, particularly photosynthesis.

Gregory A. Carter	(228) 688-1918	Gregory.Carter@ssc.nasa.gov

Remote Sensing in Chemical Oceanography — River plumes carry large loads of colored dissolved organic matter (CDOM), which strongly affect the optical properties of the water column in coastal regions. The presence of CDOM confounds the use of color satellite sensors for the determination of chlorophyll concentrations in seawater. The thrust of the research focuses on the study of changes in concentration and optical properties of CDOM along river plumes, and its effect upon the performance of biooptical algorithms used in the analysis of satellite imagery. My ultimate goal is to improve our understanding on the carbon cycling in coastal regions.

Carlos E. Del Castillo	(228) 686-2746	Carlos.Delcastillo@ssc.nasa.gov

Archeological/Anthropological Predictive Modeling — Remotely sensed satellite and airborne data can be used to detect surface anomalies that may be representative of prehistoric and historic cultural remains. Sophisticated computer-analysis techniques have been developed to extract archeological/anthropological phenomena from the visible and nonvisible portion of the electromagnetic spectrum. By combining remotely sensed and ancillary information into a database, accurate predictive models can be developed to isolate potential locations of archeological sites. Various cultural remains located in diverse environmental settings are examined to determine the spectral and spatial characteristics for the detection of archeological/anthropological features.

Marco J. Giardino	(228) 688-2739	Marco.Giardino@ssc.nasa.gov

Paleoecological Research/Human Adaptations — Focuses on the adaptation of human populations to coastal environments from prehistoric times to the present. Emphasizes interdisciplinary research to develop ecological baselines in coastal zones through the use of remotely sensed imagery, *in situ* fieldwork and the modeling of human population dynamics. Utilizes cultural and biological data from dated archaeological sites to assess the subsistence and settlement patterns of different human societies in response to changing climatic and environmental conditions, particularly those events related to episodic fluctuations in sea level.

Marco Giardino	(228) 688-2739	Marco.Giardino@ssc.nasa.gov

Remote Sensing in Biological Oceanography — The general goals of this research are to develop remote-sensing techniques, to evaluate their utility in order to improve our understanding of the behavior of oceans, and to assist users with the implementation of operational systems. Specific goals include improving our capability to measure the primary productivity of oceans, their variability, and how they influence the marine food chain and global CO_2 and biogeochemical cycles. We are also interested in improving our capability to determine phytoplankton abundance and primary productivity based on remotely sensed data acquired by spacecraft and aircraft. Primary measurements include ocean color from multispectral scanners and imaging spectrometers; and sea-surface temperature from thermal scanners on aircraft, the advanced very-high resolution radiometer, and other sensors planned for spacecraft. Algorithm development to model marine productivity on global scales through remote sensing will be necessary.

Richard L. Miller	(228) 688-1904	Richard.Miller@ssc.nasa.gov

Remote Sensing Technology — The design and development of low-cost alternatives for multispectral imaging of earth processes especially those related to coastal environments. Design and coding in innovative image processing tools related to earth system science such as data visualization, archiving, and feature extraction.

Bruce A. Spiering	(228) 688-3588	Bruce.Spiering@ssc.nasa.gov

APPENDICES

Appendix A—NASA GSRP Application/Proposal Cover Sheet/Proposal Summary

STUDENT INFORMATION

Last Name ____________________ First Name ____________________ MI _____ Birth Date ___________

Birth City/Town and State ____________________________ Birth Country ______________________________

Permanent Address	**Institution**	**Hours Completed**
	Institution:	BS / MS / PhD
Street:	**Department:**	
City:	**Street:**	**Expected Date of Graduation**
State:	**City:**	BS / MS / PhD
Zip:	**State:** **Zip:**	
Phone:	**Phone:**	**GPA**
Email:	**Email:**	BS / MS / PhD
Fax	**Fax**	

Discipline/Degree to be supported by this award:

MS PhD

Colleges or Universities Previously Attended ***(most recent first)***

Institution	Location	Dates Attended		Degree	Major

Applicant Background

Gender ☐ Male ☐ Female ☐ Individual with Disabilities

Race/Ethnicity ☐ White (not Hispanic) ☐ African American ☐ Hispanic
☐ Asian ☐ Pacific Islander ☐ American Native or Alaskan American

Proposal Information

Type of Proposal ☐ New ☐ Second Year ☐ Third Year

If Renewal, designate Grant Number: NGT _____________ Proposed Start/Renewal Date: _____/_____/_____

Proposed Title:

Submission Information *(Rank in order of preference.)*

Headquarters	☐	Space Sciences	☐	Biological and Physical Research	☐	Earth Sciences			
NASA Centers	☐	Ames	☐	Dryden	☐	Glenn	☐	Goddard	☐ Jet Propulsion Lab.
	☐	Johnson	☐	Kennedy	☐	Langley	☐	Marshall	☐ Stennis

Center Research Advisor: *(Renewals Only)*

Certification of Compliance with Applicable Executive Orders and U.S. Code

By signing and submitting the proposal identified in this GSRP Application/Proposal Cover Sheet in response to the request for a proposal under the Graduate Student Researchers Program, the Authorizing Official of the proposing institution, as identified below:

- Certifies that the statements made in this proposal are true and complete to the best of his/her knowledge;
- Agrees to accept the obligations to comply with NASA award terms and conditions if an award is made as a result of this proposal; and
- Confirms compliance with all provisions, rules, and stipulations set forth in the four Certifications contained in this solicitation [namely, (1) Certification for Debarment, Suspension, and other Responsibility Matters Primary Covered Transactions; (2) Certification Regarding Drug-Free Workplace Requirements Grantees Other Than Individuals; and (3) Certification Regarding Lobbying for Contracts, Grants, Loans, and Cooperative Agreements; and (4) Assurance of Compliance with the National Aeronautics and Space Administration Regulations Pursuant to Nondiscrimination in Federally Assistant Programs.

Institution Authorizing Official: ____ **Date** ________________________

Appendix B – Abstract and Budget Form

ABSTRACT AND BUDGET FORM

Last Name ____________________ First Name ____________________ MI _____ Birth Date ____________

Abstract *(Not to exceed100 words)*

Budget Information

Prorate Stipend and Allowances if Anticipated Tenure is Less Than 12 Months

Student Stipend **(Maximum of $18,000)**		$ ____________________
Student Allowance **(Itemize)**	Student Allowance **(Maximum of $3,000)**	$ ____________________
University Allowance **(Itemize)**	University Allowance **(Maximum of $3,000)**	$ ____________________
	Total Requested **(Maximum of $24,000)**	$ ____________________

Faculty Advisor Information		Official Responsible for Committing Institution	
Name:	____________________	Name:	____________________
Institution:	____________________	Institution:	____________________
Department:	____________________	Title:	____________________
Institution Address:	____________________	Institution Address:	____________________
	____________________		____________________
City, State, ZIP	____________________	City, State, ZIP	____________________
Campus phone:	____________________	Campus phone:	____________________
Fax #:	____________________	Fax #:	____________________
E-mail:	____________________	E-mail:	____________________
Signature:	____________________	*Signature:*	____________________
Date:	____________________	Date:	____________________

I certify that I am a citizen of the United States and that I am or will be a full-time graduate student at the university during the period for which this application/proposal is made.

Signature: ____ *Date:* ______________________________

AREA BELOW IS FOR NASA USE ONLY

_____Org/Cpys _____BdgtFrm _____Ucert _____SAE _____Tran _____ABS _____REC

Appendix C

Certification of Compliance with Applicable Executive Orders and U.S. Code

The following appendices, (C-1—C-5), are the full text of certifications related to NASA grant awards. Please read the certifications carefully. By signing and submitting the proposal identified in the GSRP Application/Proposal Cover Sheet, (see Appendix A), in response to the request for a proposal under the Graduate Student Researchers Program, the Authorizing Official of the proposing institution, as identified below:

1. certifies that the statements made in this proposal are true and complete to the best of his/her knowledge;
2. agrees to accept the obligations to comply with NASA award terms and conditions if an award is made as a result of this proposal.

Appendix C-1 Privacy Act Statement

General

Pursuant to Public Law 93-579, Privacy Act of 1974, as amended (5U.S.C.§552a), the following information is being provided to persons who are asked to provide information to obtain a NASA Graduate Student fellowship.

Authority

This information is collected under the authority of the National Aeronautics and Space Act. Publication 85-568, as amended, 42 U.S.C.§2451, et. seq.

Purposes and Uses

This information requested on the application form will be used to determine your eligibility for participation in the NASA Graduate Student Researchers Program. The information requested regarding your ethnic/racial/disability status will be used to determine the degree to which members of each ethnic/racial/disability group are being reached by NASA's announcement of this program, and will not affect your application. Additionally, NASA may disclose this information to other organizations, and other governmental agencies, as well as Congressional offices in response to an inquiry made on your behalf. Disclosure may also be made to concerned parties in the course of litigation, to law enforcement agencies, and to other Federal agencies in exchanging information pertinent to an agency decision.

Effects of Nondisclosure

Furnishing the information on the application form is voluntary, but failure to do so may result in NASA's inability to determine eligibility for participation and selection for award in the Graduate Student Researchers Program. However, your application will not be affected if you choose not to provide information on your ethnic, racial, or disability status.

Definitions for Applicant Background

- American Native or Alaskan American: A person having origins in any of the original peoples of North America and who maintains cultural identification through tribal affiliation or community recognition.
- Hispanic: A person of Mexican, Puerto Rican, Cuban, or South American or other Spanish culture or origin, regardless of race.
- Asian: A person having origins in any of the original peoples of East Asia, Southeast Asia or the Indian subcontinent. This area includes, for example, China, India, Indonesia, Japan, Korea, and Vietnam.
- Pacific Islander: A person having origins in any of the original peoples of Hawaii; the U.S. Pacific territories of Guam, American Samoa, and the Northern Marinas; the U.S. Trust Territory of Palau; the islands of Micronesia and Melanesia; or the Philippines.
- African American, not of Hispanic origin: A person having origins in any of the black racial groups of Africa.
- White, not of Hispanic Origin: A person having origins in any of the original peoples of Europe, North Africa, or the Middle East.
- Individual with Disabilities: An individual having a physical or mental impairment that substantially limits one or more major life activities; who has a record of such impairment; or who is regarded as having such impairment.

Appendix C-2

Certification Regarding
Debarment, Suspension, and Other Responsibility Matters
Primary Covered Transactions

This certification is required by the regulations implementing Executive Order 12549, Debarment and Suspension, 34 CFR Part 85, Section 85.510, Participant's responsibilities. The regulations were published as Part VII of the May 26, 1988 Federal Register (pages 19160 - 19211). Copies of the regulation may be obtained by contacting the U.S. Department of Education, Grants and Contracts Service, 400 Maryland Avenue, SW (Room 3633 GSA Regional Office Building No. 3), Washington, DC 20202-4725, telephone (202) 732-2505.

(1) The prospective primary participant certifies to the best of its knowledge and belief, that it and its principals:

  (a) Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency;

  (b) Have not within a three-year period preceding this proposal been convicted of or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State, or Local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property;

  (c) Are not presently indicted for or otherwise criminally or civilly charged by a governmental entity (Federal, State, or Local) with commission of any of the offenses enumerated in paragraph (1)(b) of this certification; and

  (d) Have not within a three-year period preceding this application/proposal had one or more public transactions (Federal, State, or Local) terminated for cause or default.

(2) Where the prospective primary participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

Appendix C-3

Certification Regarding Drug-Free Workplace Requirements
Grantees Other Than Individuals

This certification is required by the regulations implementing the Drug-Free Workplace Act of 1988, 34 CFR Part 85, Subpart F. The regulations, published in the January 31, 1989 Federal Register, require certification by grantees, prior to award, that they will maintain a drug-free workplace. The certification set out below is a material representation of fact upon which reliance will be placed when the agency determines to award the grant. False certification or violation of the certification shall be grounds for suspension of payments, suspension or termination of grants, or government wide suspension or debarment (see 34 CFR Part 85, Sections 85.615 and 85.620). This grantee certifies that it will provide a drug-free workplace by:

(a) Publishing a statement notifying employees that the unlawful manufacture, distribution, dispensing, possession or use of a controlled substance is prohibited in the grantee's workplace and specifying the actions that will be taken against employees for violation of such prohibition;

(b) Establishing a drug-free awareness program to inform employees about
    (1) the dangers of drug abuse in the workplace;
    (2) the grantee's policy of maintaining a drug-free workplace;
    (3) any available drug counseling, rehabilitation, and employee assistance programs, and
    (4) the penalties that may be imposed upon employees for drug abuse violations in the work place;

(c) Making it a requirement that each employee to be engaged in the performance of the grant be given a copy of the statement required by paragraph (a);

(d) Notifying the employee in the statement required by paragraph (a) that, as a condition of employment under the grant, the employee will (1) Abide by the terms of the statement; and (2) Notify the employer of any criminal drug statute conviction for a violation occurring in the workplace no later than five days after such conviction;

(e) Notifying the agency within ten days after receiving notice under subparagraph (d)(2), with respect to any employee who is so convicted -

(f) Taking one of the following actions, within 30 days of receiving notice under subparagraph (d)(2), with respect to any employee who is so convicted ;

    (1) Taking appropriate personnel action against such an employee, up to and including termination; or
    (2) Requiring such employee to participate satisfactorily in a drug abuse assistance or rehabilitation program approved for such purposes by a Federal, State, or local health, law enforcement, or other appropriate agency;

(g) Making a good faith effort to continue to maintain a drug-free workplace through implementation of paragraph (a), (b), (c), (e), and (f).

Appendix C-4

Certification Regarding Lobbying for Contracts, Grants, Loans, and Cooperative Agreements

The undersigned certifies, to the best of his or her knowledge and belief, that:

(1) No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form - LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, title 31, U.S. Code. Any person who fails to file the required certificate shall be subject to a civil penalty of not less than $10,000, and not more than $100,000 for each such failure.

Appendix C-5

Assurance of Compliance with the National Aeronautics and Space Administration Regulations Pursuant to Nondiscrimination in Federally Assisted Programs

The Institution, corporation, firm, or other organization on whose behalf this assurance is signed, hereinafter called "Applicant" HEREBY AGREES THAT it will comply with Title VI of the Civil Rights Act of 1964 (PL 88-352), Title IX of the Education Amendments of 1962 (20 U.S.C. 1680 et seq.), Section 504 of the Rehabilitation Act of 1973, as amended (29 U.S.C. 794), and the Age Discrimination Act of 1975 (42 U.S.C. 16101 et seq), and all requirements imposed by or pursuant to the Regulation of the National Aeronautics and Space Administration (14 CFR Part 1250) (hereinafter call "NASA") issued pursuant to these laws, to the end that in accordance with these laws and regulations, no person in the United States shall, on the basis of race, color, national origin, sex, handicapped condition, or age be excluded from participation in, be denied the benefits of, or be otherwise subjected to discrimination under any program or activity for which the Applicant receives federal financial assistance from NASA; and HEREBY GIVE ASSURANCE THAT it will immediately take any measure necessary to effectuate this agreement.

If any real property or structure thereon is provided or improved with the aid of federal financial assistance extended to the Applicant by NASA, this assurance shall obligate the Applicant, or in the case of any transfer of such property, any transferee, for the period during which the real property or structure is used for a purpose for which the federal financial assistance is extended or for another purpose involving the provision of similar services or benefits. If any personal property is so provided, this assurance shall obligate the Applicant for the period during which it retains ownership or possession of the property. In all other cases, this assurance shall obligate the Applicant for the period during which the federal financial assistance is extended to it by NASA.

THIS ASSURANCE is given in consideration of and for the purpose of obtaining any and all federal grants, loans, contracts, property, discounts, or other federal financial assistance extended after the date hereof to the Applicant by NASA, including installment payments after such date on account of applications for federal financial assistance which were approved before such date. The Applicant recognized and agrees that such federal financial assistance will be extended in reliance on the representations and agreements made in this assurance, and that the United States shall have the right to seek judicial enforcement of this assurance. This assurance is binding on the Applicant, its successors, transferees, and assignees, and the person or persons whose signatures appear below are authorized to sign on behalf of the Applicant.

NASA FORM 1206 AUG 97 PREVIOUS EDITIONS ARE OBSOLETE